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Research Article

OL 15: A high yielding, single cut variety of fodder oat developed for Punjab state

Rahul Kapoor, Amandeep* and Harshavardan J. Hilli

Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141004, Punjab

*E-Mail: mirokaman24496@gmail.com

Abstract

A new high yielding oat variety OL 15 derived from cross between HJ 8 and OL 1610 was released during the year 2021 for irrigated, timely sown conditions of Punjab. Variety reaches to 50 per cent flowering in 115-120 days and ready for harvesting for green fodder. The variety is low in Acid detergent fiber (ADF) and Neutral detergent fiber (NDF) content but possess high crude protein (CP) content, crude protein yield (CPY) as well as superior nutritional quality for *in-vitro* dry matter digestibility (IVDMD). OL 15 is semi-erect in stature with high tillering ability, good for single cut system with more desirable morphological plant characters such as plant height, leaf length and leaf width and having medium sized grains. The variety showed high responses to nitrogenous fertilizers and is moderately susceptible to powdery mildew. In the overall performance over five years, mean green forage yield of 852.46 q/ha with a superiority of 23.2 per cent over check (Kent) was recorded. The mean dry matter yield recorded for this variety was 180.1 q/ha with 31.4 per cent superiority over check (Kent). At Faridkot district of Punjab, the variety recorded the highest green forage yield (998 q/ha) which justifies the genetic potential of the variety. The variety outperforms other released and tested varieties Kent, OS 6, and OL 125 in terms of green forage yield, dry matter yield and seed yield. The crude protein yield was 10.80 q/ha with an IVDMD of 50.5 per cent and a CP content of 7.1 per cent. The variety OL 15 was recommended in the year 2021 for cultivation in Punjab state of India.

Keywords: Oat, multi-location, green forage yield, dry matter content, variety

INTRODUCTION

Oat (*Avena sativa* L.), a member of the genus *Avena* and family Poaceae is an important winter cereal crop grown throughout the country during *Rabi* season. It is best suitable for temperate regions due to their winter hardiness (Kumari *et al.*, 2019). The genus *Avena* is diverse and large and contains both cultivated species as well as wild species of different polyploidy levels. The cultivated oat is allohexaploid ($2n=6x=42$) with a basic chromosome number of $n=7$. In world cereal production, oat ranks sixth after wheat, maize, rice, barley and sorghum (Choubey and Roy, 2005). The total fodder oat-growing area in India is estimated to be around 10.0 lakh hectares and the highest area in Uttar Pradesh (34%) followed by Punjab (20%), Haryana (9%) and Madhya Pradesh (6%) out of

total area of the fodder oat (Indiastat, 2020). Oat is mainly cultivated as a fodder crop for livestock animals due to the presence of high amount of proteins, minerals and fiber. It has an outstanding growth habit, quick regeneration after cutting and good quality herbage (Ahmed *et al.*, 2020). The quality of protein in oat is excellent. Oat contains around 11-15 per cent protein and it has relatively well balanced amino acid composition (Poonia *et al.*, 2017). The crop can be cut at early stage nearly 60 to 70 days after sowing and then left for harvesting grains at maturity (Amandeep *et al.*, 2021). Fodder oat can be directly fed as green or the surplus can be converted into silage or hay can be used during the deficit period. Agriculture and livestock are essential components of the Indian

economy. The amount of livestock alone accounts for 4.11 per cent of the country's GDP. India has 15 per cent of the world's livestock population (536.76 million) showing an increment of 4.8 per cent compared to 2012 livestock census. Cattle account for 36.04 per cent, buffaloes for 20.4 per cent, sheep for 13.8 per cent, pigs for 1.69 per cent, and goats for 27.7 per cent. (DAHD & F report, 2019). As all the animal husbandry and dairy farming units have an immense contribution towards GDP, there is a greater need to maintain them properly. All the livestock units are highly dependent on superior quality fodder in sufficient amounts for most time of the year but the average availability of green forage as well as dry fodder is 35.6 per cent and 11.0 per cent, respectively throughout the year (IGFRI Vision, 2050). There is a vast gap between demand and supply of green fodder as well as dry matter during some part of the year. So, there is always a greater demand to develop high fodder yielding varieties to overcome this problem. Hence, breeding programmes were initiated to develop such varieties which have the potential to maximize yields and to minimize yield losses. In oat breeding programmes, oat breeders mainly focuses on important forage parameters such as high green as well as dry matter yield potential, resistance to diseases and insect pests, per day productivity, good nutritional quality such as high crude protein and *in-vitro* dry matter digestibility yield (Annual report AICRP-FC, 2015). To achieve higher yields, there is a greater need for screening for host plant resistance to various stresses and their mechanism of resistance.

As India has a wide range of climate, it is divided into different climatic zones. Various research centers are engaged in developing different varieties suitable for particular zone. These centers aim to meet the emerging demand of new varieties suitable for forage production. There is also a well-managed protocol for evaluating breeding lines for release and notification to farmers for cultivation. As a result, after station trials, the entries were entered into the All India Coordinated Trials. Entries that outperform the check varieties by a significant margin are presented to a committee for approval and notice of varieties for farmers to utilize. As a result, crop breeding's ultimate goal is to create varieties with high yielding potential and good agronomic features. The goal of this study was to assess the performance of oat variety OL 15 to meet the growing fodder requirement in the Punjab state.

MATERIALS AND METHODS

OL 15 is a cross between HJ 8 and OL 1610 developed during *Rabi* 2010 and stabilized in F_5 generation. Station trials were conducted to evaluate the performance of variety at Forage, Millets and Nutrition section, Punjab Agricultural University, Ludhiana from 2016-2018 along with check OL 13, OL 12 and Kent. The variety was evaluated under different agro-ecosystems/multi-locations during 2018-19, 2019-20, and 2020-21 at

different station yield trials in 3×3 square meter plot with row to row spacing of 25 cm. The plot accommodated 12 rows with each row length 3 meter and recommended package of practices were followed to raise a good crop. Green forage and dry matter yield (q/ha) were analyzed, as well as per day productivity for green forage and dry matter (q/ha). Green forage was also examined for quality characteristics such as crude protein content (per cent), crude protein yield (q/ha), *in-vitro* dry matter digestibility (IVDMD %), acid detergent fiber (ADF %) and neutral detergent fiber (NDF %). The variety was also tested for seed yield based on its performance in several trials. *Helminthosporium* leaf blight, number of aphids per tiller and other pest and disease performance trials were conducted under various field circumstances. During 2020-21, an agronomic performance experiment of the variety was done to ascertain how nitrogen affects the quality and forage productivity.

RESULTS AND DISCUSSION

The variety OL 15 was evaluated for various parameters in several years of trials. The average green fodder yield of the variety was 740.7 q/ha over two years of station trial with a 19.1% increase over check (Kent) and 156.2 q/ha of mean dry matter yield with 28.5% increase over check (Kent). The variety also recorded an average green forage yield 948.1 q/ha (**Table 1**) and dry matter yield 197.9 q/ha (**Table 2**) which justifies that the variety has genetic potential for higher yields. OL 15 has consistently recorded superior performance during multi-location trials conducted at Ludhiana, Faridkot and Gurdaspur for three years during 2018-19 to 2020-21. The variety showed superiority of 7.21 to 21.7 per cent (**Table 1**) and 13.0 to 28.5 per cent (**Table 2**) for green forage yield and dry matter yield over the checks, respectively. It recorded an average green forage yield of 926.9 q/ha and dry matter yield of 196.1 q/ha over the three years of testing.

The performance of the variety was evaluated for five years at different locations in Punjab and recorded a green forage yield of 833.8 q/ha with an increase of 23.2 per cent over check (Kent) and for dry matter yield, the variety recorded a yield of 180.1 q/ha with an increase of 31.4 per cent over the check variety (Kent). Yield performance of the variety OL 15 at different tested locations viz. Ludhiana, Faridkot and Gurdaspur ranged from 950.2-995.8, 875.0-998.6 and 805.6-933.3 q/ha for green forage yield (**Table 3**) and 200.5-214.2, 188.4-205.4 and 174.8-194.1 q/ha for dry matter yield, respectively (**Table 4**).

The variety recorded a per day green forage production potential of 5.43 q/ha/day with overall superiority of 15.3 per cent over the check variety OS 6 (**Table 5**) and dry matter per day potential of 1.13 q/ha/day with a superiority of 13.0 per cent over the check variety OL 125 (**Table 6**). As the output of the animals is mainly dependent on the quality of the fodder and its regular supply throughout the year, to determine the quality of the fodder,

Table 1. Performance of OL 15 for green forage yield (q/ha) in five years of testing

Station Trial	Entry	Check-1	Check-2	Check-3
Year	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
2016-17	655.9	752.3	675.3	616.6
2017-18	825.6	747.1	681.1	626.7
Mean	740.7	749.7	678.2	621.6
% increase over check		-1.2	9.21	19.1
Varietal Trial	Entry	Check-1	Check-2	Check-3
Year	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
2018-19	945.0	959.0	870.4	744.0
2019-20	948.1	979.5	891.7	811.9
2020-21	887.7	920.6	831.4	729.0
Mean	926.9	953.0	864.5	761.6
% increase over check		-2.7	7.21	21.7
Mean performance over five years	852.46	851.3	771.3	691.6
% increase over check		0.09	10.5	23.2

Table 2. Mean performance of OL 15 for dry matter yield (q/ha) in five years of testing

Station Trial	Entry	Check-1	Check-2	Check-3
Year	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
2016-17	139.1	158.7	133.7	119.6
2017-18	173.4	161.4	136.9	123.5
Mean	156.2	160.5	135.3	121.5
% increase over check		-2.6	15.4	28.5
Varietal Trial	Entry	Check-1	Check-2	Check-3
Year	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
2018-19	197.9	201.5	177.6	151.1
2019-20	197.7	199.4	173.9	163.2
2020-21	192.7	186.3	168.9	143.2
Mean	196.1	195.7	173.5	152.5
% increase over check		0.2	13.0	28.5
Mean performance over five years	180.1	178.1	154.4	137.0
% increase over check		1.1	16.6	31.4

Table 3. Yield performance of OL 15 at different locations over the years for green forage yield (q/ha)

Year (2018-19)	Entry	Check-1	Check-2	Check-3
Location	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
Ludhiana	995.8	977.4	882.4	735.7
Faridkot	905.8	916.3	820.1	701.3
Gurdaspur	933.3	983.3	908.8	795.0
Mean	945.0	959.0	870.4	744.0
% increase over check		-1.4	8.5	27.0
Year (2019-20)	Entry	Check-1	Check-2	Check-3
Location	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
Ludhiana	950.2	962.5	897.6	785.7
Faridkot	998.6	1033.3	950.0	887.5
Gurdaspur	895.6	942.7	827.5	762.5
Mean	948.1	979.5	891.7	811.9
% increase over check		-3.2	6.3	16.7
Year (2020-21)	Entry	Check-1	Check-2	Check-3
Location	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
Ludhiana	982.6	970.7	915.8	802.3
Faridkot	875.0	968.8	739.5	729.1
Gurdaspur	805.6	822.2	838.9	655.6
Mean	887.7	920.6	831.4	729.0
% increase over check		-3.5	6.7	21.7

LC=local check

Table 4. Yield performance of OL 15 at different locations over the years for dry matter yield (q/ha)

Year (2018-19)	Entry	Check-1	Check-2	Check-3
Location	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
Ludhiana	211.1	213.1	179.1	145.7
Faridkot	188.4	189.7	167.3	143.8
Gurdaspur	194.1	201.6	186.3	163.8
Mean	197.9	201.5	177.6	151.1
% increase over check		-1.78	11.4	30.9
Year (2019-20)	Entry	Check-1	Check-2	Check-3
Location	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
Ludhiana	200.5	198.3	172.3	155.6
Faridkot	205.4	207.7	187.1	179.3
Gurdaspur	187.1	192.3	162.2	154.8
Mean	197.7	199.4	173.9	163.2
% increase over check		-0.8	13.6	21.1
Year (2020-21)	Entry	Check-1	Check-2	Check-3
Location	OL 15	OL 13 (LC)	OL 12 (LC)	Kent (LC)
Ludhiana	214.2	196.1	188.7	158.1
Faridkot	189.0	197.6	149.4	142.2
Gurdaspur	174.8	165.3	168.6	129.2
Mean	192.7	186.3	168.9	143.2
% increase over check		3.4	14.0	34.5

Table 5. Per day production potential of green forage yield (q/ha/day) of OL 15 over the years in Punjab

Years	Entry	National checks		Zonal check
	OL 15	Kent	OS 6	OL 125
2016-17	4.83	4.91	4.28	5.39
2017-18	5.04	4.69	4.42	4.86
2018-19	6.42	5.63	5.44	4.91
Mean	5.43	5.08	4.71	5.06
% superiority over check		6.9	15.3	7.3

Table 6. Per day production potential of DMY (q/ha/day) of OL 15 over the years in Punjab

Years	Entry	National checks		Zonal check
	OL 15	Kent	OS 6	OL 125
2016-17	1.01	0.93	1.13	1.15
2017-18	0.98	0.99	0.89	0.93
2018-19	1.40	1.11	1.14	0.91
Mean	1.13	1.01	1.05	1.00
% superiority over check		11.9	7.6	13.0

different quality related parameters such as crude protein content (CP), crude protein yield (CPY), acid detergent fiber (ADF), neutral detergent fiber (NDF) and *in-vitro* dry matter digestibility (IVDMD) were also estimated. During the testing period from 2016-19, the variety recorded CPY 10.8 (q/ha) with a superiority of 29.8 per cent over check variety OS 6 (Table 7). The crude protein content was 7.1 per cent with an increase of 4.4 per cent over check variety OS 6 (Table 7). IVDMD of the variety was 50.5 per cent over the years (Table 7). The value of ADF and NDF for the variety OL 15 was 43.4 per cent and 61.2 per cent during the three years of testing in Punjab (Table 7).

Green forage yield is a complex trait and is correlated with several other traits which may have positive or negative effect on green forage yield. These traits have a greater influence towards green forage yield. So, keeping in view the relation between different traits, the observation for various green forage yield related traits such as plant height, leaf length, leaf width and leaf: stem ratio were recorded during the years of testing of the variety. The variety OL 15 recorded a mean plant height of 154.6 cm, Leaf length of 43.5 cm, Leaf width of 4.19 cm and Leaf: stem ratio 0.91 (Table 8). The consolidated results showed that variety OL 15 recorded a grain yield of

24.5q/ha which is superior to the check varieties OL 13, OL 12 and Kent (**Table 9**).

Oat is an important forage crop grown during winter season at a very large area in the country. The crop is attacked by several diseases and insect pests during its growth period. So, to cope with these biotic stresses, a good level of resistance should be present. OL 15 was screened for resistance to powdery mildew during the years of testing and it was recorded that the variety OL 15 is moderately susceptible to powdery mildew (**Table 10**).

OL 15 is suitable for single cut cultivated system as the plants are of semi-erect type and with medium size of seeds. Also, the variety showed resistance to lodging and behaved as a non-shattering type. OL 15 takes around 115-120 days to 50 per cent flowering and 145-150 days to maturity. The panicle color of entry remains green at young stage and has the 1000-seed weight of 27 g (**Table 11**).

The performance of the variety OL 15 was also recorded to be superior in All India Coordinated Trials (**Table 12**). OL 15 recorded an average green forage yield of 448.7 q/ha with a superiority of 15.1 per cent over the national check OS 6 and 2.4 per cent over the best qualifying entry HFO 607. The variety also recorded dry matter yield of 92.9 q/ha with a superiority of 12.7 per cent over the national check OS 6 and 4.2 per cent over the qualifying entry JO-05-07. The performance of the variety for different quality traits was also superior over the national checks (Kent and OS 6) and the qualifying entries (OL 1869-1, HFO 607 and JO-05-07).

Notification of the variety

OL 15 was identified under the name OL 1861 by the Variety Identification Committee, met on 30th August 2019 at National Group Meet of All India Coordinated Research Project on Forage Crops and Utilization held at CAU, Imphal. It was released and notified by the Central Subcommittee on Crop Standards, Notification and Release

Table 7. Quality parameters of OL 15 over the years (2016-19)

Trait	OL 15	Kent (NC)	OS 6 (NC)	OL 125 (ZC)
CPY (q/ha)	10.80	10.05	8.32	9.40
% increase over check		7.5	29.8	14.9
CP%	7.1	7.9	6.8	8.1
% increase over check		-10.1	4.4	-12.3
IVDMD %	50.5	55.5	52.7	53.4
ADF%	43.4	42.8	44.6	42.2
NDF%	61.2	61.2	63.8	60.1

CPY=crude protein yield, CP=crude protein, IVDMD=in-vitro dry matter digestibility, ADF=acid detergent fiber, NDF=neutral detergent fiber

Table 8. Morphological characters of OL 15

Characters	Varieties			
	OL 15	OL 13	OL 12	Kent
Plant height (cm)	154.6	149.8	137.8	129.1
Leaf length (cm)	43.5	42.8	40.7	38.2
Leaf width (cm)	4.19	3.98	2.81	2.57
Leaf: stem ratio (LSR)	0.91	0.89	0.81	0.60
Stem thickness (cm)	0.82	0.78	0.76	0.60
Number of tillers/plant	14.6	15.5	13.7	11.0
Number of leaves/plant	75.0	78.0	65.7	50.0
Number of days from sowing to cutting	132.8	128.6	122.5	115.0
Lodging Score	1.37	1.22	1.0	0.89

Table 9. Seed yield of OL 15 in Punjab

Variety	Seed yield (q/ha)				Mean
	2016-17	2017-18	2018-19	2020-21	
OL 15	23.1	23.7	25.8	25.3	24.5
OL 13	22.6	23.4	25.1	24.7	24.0
OL 12	21.7	22.2	24.0	23.6	22.9
Kent	20.2	21.0	23.7	23.2	22.0

Table 10. Reaction to diseases at Ludhiana location for powdery mildew over the years

Year	Disease Index	Varieties			
		OL 15	Kent	OL 13	OL 12
2016-17	% Disease severity	26.3	51.3	25.3	28.7
2017-18	% Disease severity	24.0	49.0	26.0	27.0
2018-19	% Disease severity	26.0	35.0	26.3	25.7
2019-20	% Disease severity	27.3	49.2	26.4	29.7
2020-21	% Disease severity	26.3	48.3	25.8	27.8

Score: 1 (1-10.0%): Resistant (R), 2 (10.1-25.0%): Moderately Resistant(MR), 3 (25.1-50.0%): Moderately Susceptible (MS), 4 (50.1-75.0%): Susceptible (S), 5 (>75%): Highly Susceptible (HS)

Table 11. Distinguished morphological description of oat variety OL 15

Trait	Characteristics
Growth habit	Semi-erect
Foliage	Green
Flower colour	Green
Days to 50% flowering	115-120
Days to maturity	145-150
1000-seed weight (g)	27
Panicle colour	Green at young stage
Seed colour	Creamish yellow
Seed shape and size	Narrow, long

Table 12. Overall Performance (mean of three years and over all the locations) of OL 15 against national/zonal checks at National level (HZ, NWZ, NEZ, CZ and SZ)

Trait	Proposed variety OL 15	National checks		Best qualifying entries		
		Kent	OS 6	OL 1869-1	HFO 607	JO-05-7
GFY (q/ha)	448.7	410.9	389.7	435.4	438.4	423.0
% superiority		9.2	15.1	3.0	2.4	6.1
DMY (q/ha)	92.9	86.7	82.3	88.7	94.2	89.0
% superiority		7.1	12.7	4.6	-1.5	4.2
GFY (q/ha/day)	4.64	4.50	4.38	4.69	4.59	4.44
% superiority		3.1	5.9	-1.0	1.0	4.6
DMY (q/ha/day)	0.98	0.97	0.95	0.99	1.00	0.96
% superiority		0.7	3.2	-1.3	-1.7	2.1
Plant height (cm)	129.7	119.4	123.7	124.9	130.7	121.5
% superiority		8.7	4.8	3.9	-0.8	6.7
LSR	0.66	0.64	0.65	0.65	0.62	0.65
		3.1	1.5	1.5	6.5	1.5
CPY(q/ha)	7.9	7.5	7.0	7.6	8.2	7.5
% superiority		5.3	12.9	3.9	-3.7	5.3
Crude Protein (%)	8.7	8.7	8.6	8.5	8.5	8.5

HZ=hill zone, NWZ=north west zone, NEZ=north east zone, CZ=central zone, SZ=south zone, GFY=green forage yield, DMY=dry matter yield, LSR=leaf stem ratio, CPY=crude protein yield

of Varieties for Agricultural Crops (CSC on CSN&RVAC) vide its gazette notification number S.O. 3482(E) October 7, 2020. This variety was recommended for cultivation in whole of the irrigated areas of all India (except Hill zone) comprising of states like Punjab, Haryana, Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Madhya Pradesh,

Chattisgarh, Assam, Imphal, Kolkata, Jharkhand, Bihar, Odisha, Hyderabad, Karnataka and Tamil Nadu. In Punjab State, the variety was notified by the proceedings of the State Variety Approval Committee meeting for Field Crops held on 18-08-2021. The variety has entered into seed chain for distribution of quality seed to the farmers.

The new oat variety OL 15 recorded better green fodder yield and dry matter yield than the local checks OL 13, OL 12 and most popular variety 'Kent'. This new variety also possesses good fodder quality characters especially the crude protein which will improve the milk quality and yield of the milch animals, and ultimately improves the economic returns to the dairy farmers. Due to its better fodder yield potential and better tolerance insect pest and diseases this new variety will give very good returns to the farmers.

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