The Pharma Innovation Journal 2022; 11(12): 1076-1086

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 1076-1086

www.thepharmajournal.com
Received: 08-09-2022
Accepted: 12-10-2022

Alka Singh
Ph.D. Scholar, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Dr. S.K. Jha
Principal Scientist, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Dr. V.K. Samadhiya
Principal Scientist, Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Corresponding Author:
Alka Singh
Ph.D. Scholar, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Effect of different varieties, date of sowing and cutting management on yield attributes and yield for seed productivity of oat (*Avena sativa* L.)

Alka Singh, Dr. S.K. Jha and Dr. V.K. Samadhiya

Abstract
The present investigation entitled "Effect of different varieties, date of sowing and cutting management on yield attributes and yield for seed productivity of oat" was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during *Rabi* season of 2018-19 and 2019-20. Experiment was laid out in strip split plot design with three replications. In the experiment field was divided into vertical strips and horizontal strips further horizontal strips divided in to sub plots. In the experiment varieties, cutting management and date of sowing were evaluated for seed production of fodder oat. In this experiment two varieties: V_1-JHO-822 and V_2-RO-19 was allotted in vertical strips further three dates of sowing: D_1-Last week of October (MW-44), D_2-Second week of November (MW-46) and D_3-Last week of November (MW-48) was taken in horizontal strip and in sub plots three cutting management: C_0-No cut seed to seed, C_1-One cut at 45 DAS + seed and C_2-One cut at 60 DAS + seed was randomized. Influence of above treatments on varieties was studied for yield attributes and seed yield, feasibility of oat seed production and were computed and analyzed statistically. Significantly highest seed yield (29.87 q ha^{-1}) was recorded under the combination of oat variety JHO-822, when crop was sown at last week of October and one cutting was taken at 45 days after sowing and crop was left for seed production. Whereas, this combination was found at par with the combinations of variety JHO-822 and sowing at second week of November and one cut at 45 days after sowing (28.51 q ha^{-1}) and variety JHO-822 sown at last week of October with seed to seed where no cut (27.47 q ha^{-1}) was taken.

Keywords: Sowing dates, cutting managements, oat, cultivars, seed yield

Introduction
Oat (*Avena sativa* L.), also known as *Javi*, is a major cereal crop that is primarily farmed for fodder during the *Rabi* season and is mostly grown under irrigated conditions in India's northern and north-western regions. Oats are an annual crop in India, belonging to the Poaceae genus "*Avena*". It ranks 6th in world cereal production following wheat, rice, maize, barley and sorghum. It is gentle enough and rich in energy. This crop is well adapted to a wide range of soil types and on acid soils can perform better than other small grain cereals.

Oats are produced on 9.46 million ha around the world, with a yield of 2.42 metric tonnes ha^{-1} and a production of 22.91 million metric tonnes. (Anonymous, 2019) [2]. Russia, the United States, Canada, Poland, China, France, and Australia are among the countries that grow oats extensively. Cultivated fodder in India is limited to 4.9 percent of total cropped land (Kumar *et al*. 2012) [3]. In India oat is grown on 100,000 hectares of area with productivity of 35-40 tonnes of green fodder per hectare. Oats are mostly farmed for fodder in the *Rabi* season in the states of Uttar Pradesh, Punjab, Bihar, Haryana, West Bengal, M.P. and Chhattisgarh (Anonymous, 2014) [1]. Oat is an essential fodder crop that is commonly planted for green fodder as well as seed in many parts of the world throughout the winter season.

Oat has a well-balanced nutritional composition. It is a good source of carbohydrate, vitamin B and 53.2% nitrogen free extract. Beside this, it contains 2.31% ether extract, 9.33% total ash, 0.47% calcium, 0.22% phosphorus, 0.22% magnesium, 0.52% sodium and 2.84% potassium, iron and excellent source of high-quality protein with good amino acid composition. Oat contains high percentage of oat lipids especially unsaturated fatty acid, minerals, vitamins and phytochemicals. It has the highest nutritive value; it contains 10-12% crude protein, 30-32% digestible crude fiber and has highest dry matter digestibility of 60-70% (Sharma *et al.* 1999) [24]. They are typically sown in the winter, grazed prior to stem elongation and harvested when fully mature for use as feed and or milling grains. Typically, multiple cuts are made, after which part or all of the crop is kept for seed.

It has a sufficient amount of soluble carbs and fibre (Peterson *et al.* 2005) [4].

According to the 20th Livestock Census 2019, the country's overall livestock population is 535.78 million, with 02.79 million bovine population (cattle, buffalo, mithun, and yak). In 2019, the total number of cattle in the country was 97.17 million, up 0.8% from the previous census. Chhattisgarh has a thriving cattle industry and is a vital part of the rural economy. The state's livestock population is estimated to be 158.72 lakhs, including 99.84 lakhs of cattle, 11.75 lakhs of buffaloes and 47.13 lakhs of other animals like as sheep, goats, horses and other species. The state's livestock productivity is low (Anonymous, 2019) [2].

The oat crop is new to Chhattisgarh, seed output is limited. For oat seed, farmers and the state government must rely on other states and agencies. The temperature and soil in the state are perfect for oat seed production, but there are currently no agro techniques for fodder oat seed production offered. As a result, we will evaluate the seed production technology of numerous cultivars for the state of Chhattisgarh using seed rate manipulation, sowing method, sowing date and cutting management procedures in this suggested study. This study will assist seed producers, state fodder seed producers and framers in becoming self-sufficient in fodder oat seed.

Maintaining a balanced feed and fodder supply in the state is critical for making the animal husbandry sector more viable and productive. Stall-feeding can be used to streamline the fodder supply with more nutritious feed and fodder, resulting in a more productive milch herd, which will accelerate the rise of milk output in the state.

Green fodder and seed requirements are currently unfulfilled in Chhattisgarh due to a high livestock population with low productivity, a scarcity of community grazing land, a lack of proper fodder management in grazing land, fragmented and small land in the state, small farmers in the state prioritizing commercial crop cultivation, fodder production on very small land in the state, a lack of technical knowledge about fodder production, and a lack of good grazing land. The main causes of fodder shortage in the state are a lack of good quality fodder seed in sufficient quantities and a lack of a fodder seed production chain.

Although this crop is not as widely grown as other cereals, its increasing popularity as a fodder crop in recent years has emphasized the need for more research, particularly in terms of selecting appropriate strains and production strategies for various agro-climatic zones across the country. Despite the potential for growing under intensive cropping systems, there is a lack of information on the best varieties and management practices for generating quality seed, such as JHO-822, JO-1, RO-19, Kent and OS-6 in the state.

The sowing date is important for plant growth because it offers a favorable environment for the plants and allows them to grow taller. The utilization of sowing time can help to alleviate the green fodder scarcity to some extent. We should be finished sowing by mid-November. In late-sown oats, the yield of multi-purpose oats is reduced. When the crop was sowed in mid-October, the highest seed yield and straw output were achieved. The sowing season has a big impact on the supply of feed. The availability of green feed may be affected by adjusting the sowing period and cutting management of oats. Sowing time is one of the most important yield contributing factors.

Seed yield is also affected by cutting management. It is another component that influences the quality of fodder since it affects the succulent, dry matter, crude protein, and other quality variables. Cutting is important strategy for increasing fodder and seed yield. Fodder oat is often cultivated as a single cut crop due to several factors such as lodging susceptibility, resulting in reduced green fodder output and quality. To overcome these challenges and increase productivity and quality, oats can be produced as a multicut crop. It will also improve seed production quality by increasing the availability of green fodder and converting the remaining amount into silage or hay over a longer period of time, even during lean periods.

Material and Methods

A field experiment was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during *Rabi* season of 2018-19 and 2019-20. The soil of experimental field was clayey in texture (*Vertisols*) locally known as Kanhar. The soil was neutral (pH 7.0-7.3) in reaction with medium in fertility having 0.66-0.69% soil organic carbon, low nitrogen (250-252 kg ha^{-1}), low phosphorus (16-18 kg ha^{-1}) and high potassium (320.31-324.42 kg ha^{-1}) content, the experiments, date of sowing and cutting management on oat varieties for seed production were under taken during two consecutive *Rabi* seasons of 2018-19 and 2019-20. The experiments were laid out in strip split plot design with three replications. In the experiment field was divided into vertical strips and horizontal strips further horizontal strips divided in to sub plots. In the experiment varieties, cutting management and date of sowing were evaluated for seed production of fodder oat. In this experiment two varieties: V_1-JHO-822 and V_2-RO-19 was allotted in vertical strips further three dates of sowing: D_1-Last week of October (MW-44), D_2-Second week of November (MW-46) and D_3-Last week of November (MW-48) was taken in horizontal strip and in sub plots three cutting management: C_0-No cut seed to seed, C_1-One cut at 45 DAS + seed and C_2-One cut at 60 DAS + seed was randomized. Sowing was done manually at a depth of 5 cm with distance of 30 cm between the rows and recommended dose of fertilizer of 120:60:40 N: P_2O_5: K_2O ha^{-1} was applied. Nitrogen was applied in two splits, 50 percent at basal and 50 percent after first cut. Cut the top of the oats 8-10 cm from the ground while cutting so that they can develop rapidly.

Harvest index (%)

$$HI\ (\%) = \frac{\text{Economic yield (g) per plant}}{\text{Biological yield (g) per plant}} \times 100$$

Results and Discussions

The finding of present study as well as relevant discussion have been presented under following heads:

Number of panicle (m^{-2})

Data pertaining to number of panicles was influenced significantly due to variety, date of sowing and cutting managements, during 2018-19 and 2019-20 are presented in (Table. 1).

Among the varieties, significantly highest number of panicles was recorded under the variety JHO-822 statistically superior over RO-19 during both the years and mean over the years.

As regard date of sowing, significantly highest number of panicles was recorded while crop was early sown at last week of October produced significantly superior over to when crop was sown last week of November during both the years and

mean over the years. These findings are in conformity with the findings of Singh *et al*. (1998) [5].

The data regarding to different cutting managements, significantly highest number of panicles was noted when one cut was taken at 45 days after sowing and crop was left for seed production as compare to other treatments but it was at par with no cut seed to seed treatment during both the years and mean over the years. Similar data was also reported by Malik *et al*. (2015) [6] which indicate that the minimum number of panicles were noticed when the crop was harvested for fodder at 60 DAS and then left for seed purpose. This may be due to the reason early cutting of fodder give more time for the reproductive phase.

The interaction effects among varieties, date of sowing and cutting managements was significantly influenced with respect to number of panicles during both the years and over mean data (Table: 2 to 4). The significantly highest number of panicles was obtained under the combination of variety JHO-822 X crop sown last week of October X when one cut was taken at 45 days after sowing and crop was left for seed production ($V_1D_1C_1$) during both the experimental years but it was at par with variety JHO-822 X with second week of November X when one cut was taken at 45 days after sowing and crop was left for seed production ($V_1D_2C_1$) during both years and mean data.

Panicle length (cm)

Data pertaining to panicle length was influenced significantly due to variety, date of sowing and cutting managements, during 2018-19 and 2019-20 are presented in (Table 1).

As regard to varieties, significantly highest panicle length were recorded under the variety JHO-822 as compared to RO-19 during both the years and mean over the years.

Among the date of sowing, significantly superior panicle length was noted while crop was sown at last week of October as compared to other sowing dates *i.e.* last week of November and second week of November. Higher panicle length of early sown crop might be due to favorable temperature at the time of panicle initiation and longer period for growth and photosynthesis.

The data regarding to cutting managements, significantly highest panicle length was recorded when one cut was taken at 45 days after sowing and crop was left for seed production as compare to other treatments but it was at par with no cut seed to seed treatment during 2018-19 and 2019-20 and mean over the years.

The interaction effect among varieties, date of sowing and cutting management was found significant with respect to panicle length during both the seasons and years of study and over mean data (Table 5 to 7). The significantly highest panicle length was obtained under the combination of variety JHO-822 X sowing at last week of October X one cut at 45 days after sowing and crop was left for seed production but it was at par with variety JHO-822 X crop sown last week of October X seed to seed production during both the experimental years and mean over data.

Table 1: No. of panicle (m^{-2}), panicle length (cm) and panicle weight (g) of fodder oat as influenced by varieties, date of sowing and cutting management

Treatment		No. of panicle (m^{-2})			panicle length (cm)			Panicle weight (g)		
		2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
A. Varieties										
V_1	JHO-822	195.9	191.6	193.8	32.00	31.13	31.57	4.75	4.61	4.68
V_2	RO-19	181.2	169.9	175.6	30.20	28.73	29.47	4.33	4.00	4.16
SEm±		2.2	2.5	0.6	0.18	0.22	0.05	0.06	0.10	0.07
CD(P=0.05)		13.3	15.4	3.5	1.12	1.36	0.31	0.35	0.60	0.40
B. Date of sowing										
D_1	Last week October	193.0	188.1	190.6	33.00	31.55	32.28	4.91	4.71	4.81
D_2	Second week November	189.6	181.0	185.3	31.32	29.91	30.61	4.56	4.34	4.65
D_3	Last week November	183.1	173.2	178.2	28.99	28.33	28.66	4.14	3.87	4.01
SEm±		0.7	0.9	0.5	0.22	0.27	0.21	0.10	0.11	0.05
CD(P=0.05)		2.7	3.6	2.0	0.88	1.05	0.84	0.38	0.42	0.20
C. Cutting management										
C_0	No cut seed to seed	187.8	181.2	184.5	31.40	30.12	30.76	4.56	4.36	4.58
C_1	One cut at 45 DAS + Seed	197.2	188.8	193.0	32.56	31.48	32.02	4.90	4.81	4.86
C_2	One cut at 60 DAS + Seed	180.8	172.3	176.5	29.35	28.19	28.77	4.16	3.74	3.95
SEm±		4.0	4.3	3.3	0.55	0.61	0.44	0.13	0.16	0.10
CD(P=0.05)		11.8	12.5	9.6	1.60	1.79	1.28	0.38	0.47	0.30
Interaction VX D X C		S	S	S	S	S	S	S	S	S

Table 2: Number of panicle (m^{-2}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Number of panicle (m^{-2})					
	2018-19					
	V_1: JHO-822			V_2: RO-19		
	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November
C_0: No cut seed to seed	197.37	196.03	193.03	186.70	183.03	170.37
C_1: One cut at 45 DAS + seed	214.70	211.70	195.70	188.37	183.70	189.03
C_2: One cut at 60 DAS + seed	185.37	181.03	188.37	185.70	182.03	162.03
SEm±	5.83					
CD (P=0.05)	17.03					

Table 3: Number of panicle (m^{-2}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Number of panicle (m^{-2})					
	2019-20					
	V_1: JHO-822			**V_2: RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	192.93	197.03	185.12	178.89	170.83	162.64
C_1: One cut at 45 DAS + seed	204.03	202.37	190.85	190.59	172.18	172.69
C_2: One cut at 60 DAS + seed	200.69	173.55	178.12	161.45	169.82	149.92
SEm±	6.16					
CD (P=0.05)	17.99					

Table 4: Mean of Number of panicle (m^{-2}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Number of panicle (m^{-2})					
	Mean					
	V_1: JHO-822			**V_2: RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	195.1	196.5	189.1	182.8	176.9	166.5
C_1: One cut at 45 DAS + seed	209.4	207.0	193.3	189.5	177.9	180.9
C_2: One cut at 60 DAS + seed	193.0	177.3	183.2	173.6	175.9	156.0
SEm±	3.5					
CD (P=0.05)	10.1					

Table 5: Panicle length (cm) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Panicle length (cm)					
	2018-19					
	V_1: JHO-822			**V_2:RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	35.03	32.17	29.37	31.73	31.57	28.53
C_1: One cut at 45 DAS + seed	36.20	32.87	31.93	32.73	32.43	29.17
C_2: One cut at 60 DAS + seed	31.35	31.27	27.87	30.97	27.60	27.07
SEm±	0.75					
CD (P=0.05)	2.19					

Table 6: Panicle length (cm) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Panicle length (cm)					
	2019-20					
	V_1: JHO-822			**V_2:RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	32.18	31.36	30.56	31.75	27.83	27.06
C_1: One cut at 45 DAS + seed	34.42	32.10	31.75	32.11	31.13	27.36
C_2: One cut at 60 DAS + seed	30.99	30.17	26.67	27.85	26.88	26.61
SEm±	0.84					
CD (P=0.05)	2.46					

Table 7: Mean of Panicle length (cm) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Panicle length (cm)					
	Mean					
	V_1: JHO-822			**V_2: RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	33.60	31.76	29.96	31.74	29.70	27.80
C_1: One cut at 45 DAS + seed	35.31	32.48	31.84	32.42	31.78	28.26
C_2: One cut at 60 DAS + seed	31.17	30.72	27.27	29.41	27.24	26.84
SEm±	0.59					
CD (P=0.05)	1.73					

Panicle weight (g)

In the system of oat, the grain weight of panicle shows greater efficiency in promoting positive direct effects on grain yield. Panicle weight, spikelet's per panicle and seed weight in oat enhances oat seed production. Data pertaining to panicle weight was recorded after harvest and significantly influenced by variety, date of sowing and cutting management are presented in Table 1.

Among the varieties, significantly maximum mean panicle weight was noted under the variety JHO-822 (4.68 g) statistically compared to RO-19 during both the years and mean over the years. The differences in panicle weight among the varieties may be due to genetic makeup of variety.

Regarding different date of sowing, significantly maximum mean panicle weight was noted when crop was early sown at last week of October (4.81 g) as compare to other treatments but it was at par with second week of November treatment during both the years and mean over the years.

Among the different cutting management significantly superior mean panicle weight recorded when one cut was taken at 45 days after sowing and crop was left for seed production (4.86 g) as compared to when one cut was taken at 60 days after sowing and crop was left for seed production but it was at par with seed to seed treatment during both the years and mean over the years. One cut at 60 days after sowing decreased panicle weight as compared to others cuttings which may be due to less period available for growth of panicle weight.

The interaction effect among varieties date of sowing and cutting management was found significant with respect to panicle weight during both the seasons and years of study and mean data (8 to 10). The significantly highest panicle weight was obtained under the combination of variety JHO-822 X sowing at last week of October X one cut at 45 days after sowing and crop was left for seed production but it was at par with variety JHO-822 X crop sown last week of October X seed to seed production and variety JHO-822 X crop sown second week of October X one cut was taken at 45 days after sowing and crop was left for seed production during both years and mean over the years.

Table 8: Panicle weight (g) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Panicle weight (g)					
	2018-19					
	V_1: JHO-822			**V_2: RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	5.40	4.75	4.37	4.43	4.35	4.05
C_1: One cut at 45 DAS + seed	5.43	4.90	4.84	5.35	4.83	4.07
C_2: One cut at 60 DAS + seed	4.61	4.63	3.78	4.23	3.92	3.76
SEm±	0.19					
CD (P=0.05)	0.55					

Table 9: Panicle weight (g) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Panicle weight (g)					
	2019-20					
	V_1: JHO-822			**V_2: RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	5.16	5.13	3.83	4.32	3.87	3.83
C_1: One cut at 45 DAS + seed	5.20	5.17	4.67	5.13	4.43	4.23
C_2: One cut at 60 DAS + seed	4.83	3.80	3.67	3.63	3.53	2.98
SEm±	0.20					
CD (P=0.05)	0.57					

Table 10: Mean of panicle weight (g) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Panicle weight (g)					
	Mean					
	V_1: JHO-822			**V_2:RO-19**		
	D_1 Last week of October	**D_2 Second week of November**	**D_3 Last week of November**	**D_1 Last week of October**	**D_2 Second week of November**	**D_3 Last week of November**
C_0: No cut seed to seed	5.28	4.94	4.10	4.38	4.11	3.94
C_1: One cut at 45 DAS + seed	5.32	5.03	4.75	5.24	4.63	4.15
C_2: One cut at 60 DAS + seed	4.72	4.22	3.80	3.93	3.73	3.37
SEm±	0.12					
CD (P=0.05)	0.36					

Filled grains panicle^{-1}

Data regarding filled grains per panicle as influenced by varieties date of sowing and cutting management system are given in Table 11.

As regard to varieties, significantly highest filled grains per panicle was recorded under the variety JHO-822 as compared to variety RO-19 during 2018-19 and 2019-20. This may be probably due to genetic superiority of variety JHO-822.

Among the date of sowing significantly maximum filled grains per panicle was recorded under when crop was sown last week of October as compare to other late sown dates but it was par with second week of November during both the experimental years and mean data. The decrease in number of filled grain per panicle with delayed sowing may be due to small size of the panicle and poor vegetative growth of the plants. Similar results were also obtained by Joshi and Singh (1982) [7]. And increases number of filled grain per panicle may be due to suitability of weather conditions, during the pollination and fertilization processes. This suitability enhances success of the number of fertilized florets in panicle and this in turn is reflected positively in number of grains in panicle.

Among the cutting management, significantly highest the filled grains per panicle was recorded in the treatment when one cut was taken at 45 days after sowing and crop was left for seed production as compare to other treatments but it was par with no cut seed to seed treatment during both the years and mean over the years. The decrease in number of filled grain per panicle may be due to smaller size of the panicle. Similar results were reported by Taneja *et al.* (1981) [8].

Interaction of varieties, date of sowing and cutting management did not significant for filled grains per panicle during both the experimental years and over mean data.

Unfilled grains panicle^{-1}

Data regarding unfilled grains panicle^{-1} as influenced by varieties date of sowing and cutting management system are given in Table 11.

Among the varieties, significantly highest unfilled grains per panicle was noted under the variety RO-19 (7.75 and 9.04 unfilled grain panicle^{-1} in 2018-19 and 2019-20) as compare to JHO-822 during both the years and mean over the years.

The data on different date of sowing significantly superior unfilled grains per panicle was recorded when crop was sown at last week of November (6.57 and 9.45 unfilled grain panicle^{-1} in 2018-19 and 2019-20) over to last week of October during both the years and mean data. The higher unfilled grain in present chaffy grain in when crop was late sown date.

As regards different cutting management, significantly maximum the chaffy grain was recorded in treatment when one cut was taken at 60 days after sowing and crop was left for seed production (6.79 and 9.10 unfilled grain in 2018-19 and 2019-20) as compared to one cut was taken at 45 days after sowing and crop was left for seed production during both the years and mean over the years.

Interaction of varieties, date of sowing and cutting management did not significant for unfilled grains per panicle during both the seasons and years and over mean data.

100 seed weight (g)

Data regarding 100 seed weight (g) as influenced by varieties date of sowing and cutting management system are given in Table 11.

Among the varieties, 100 seed weight (g) was found non-significant. Highest 100 seed weight was recorded under the variety JHO-822 as compared to RO-19 during 2018-19 and 2019-20.

Among the date of sowing, 100 seed weight (g) was found non-significant. Maximum 100 seed weight was recorded under at last week of October as compare to last week of November during the both years and mean data. In early sowing the weight of 100 seed weight is higher due to the increase in area of the flag leaf. This area increase contributes to supplication of the pills by 45% of Carbohydrates needed to fill grain by virtue of its location directly below the deltoid, thus increasing efficiency of light interception. Therefore, photosynthetic products represented by glucose sugar is converted to a greater extent and this conversion is transformed by polymerization process into starch and then stored temporarily in plastids and finally moves to the grain (Baloch *et al*., 2010) [9]. Maximum 100 seed weight due to more time available to plant for photosynthesis and stronger source and sink relation was estimated accumulation in seed.

As regard cutting management, significantly influenced the 100 seed weight observed under when one cut at 45 days after sowing and crop was left for seed production as compare to one cut at 60 days after sowing and crop was left for seed production during both the years and over mean data. 100 seed weight was reduced with delay in period of cutting. Early maturity and less translocation of food material might have affected the 100 seed weight in oat cut at later periods of cutting. These results are conformity with the earlier finding of Ghosh (1985) [10].

Interaction effects of varieties, date of sowing and cutting management did not significantly for 100 seed weight during both the experimental years of study and over mean data.

Seed set (%)

The Data presented in Table 11. Revealed that seed set (%) influenced by varieties date of sowing and cutting management during both the years in *Rabi* oat.

Among the verities significantly higher mean seed set was recorded under the variety JHO-822 (92.93 seed set percent) statistically over the variety RO-19 during both the years and mean over data.

Seed set (%) was significantly influenced by date of sowing. Higher mean seed set was recorded when crop was sown at last week of October (91.98%) as compare to last week of November during both the season and mean over the years, but it was at par with second week of November during 2018-19.

Seed set percent was influenced significantly by cutting managements. Higher seed set was recorded in when one cut was taken 45 days after sowing and crop was left for seed production (92.31%) as compare to other treatments during both the years and mean over the years.

The interaction effects amongst varieties, date of sowing and cutting managements was found non-significant with respect to seed set percent during both the years and mean over the years.

Table 11: Filled grain panicle^{-1}, unfilled grain panicle^{-1}, 100 seed weight (g) and seed se (%) of fodder oat as influenced by varieties, date of sowing and cutting managements

Treatment		Filled grain panicle^{-1}			Unfilled grain panicle^{-1}			100 seed weight (g)			Seed set (%)		
		2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
A. Varieties													
V_1	JHO-822	72.04	68.16	70.10	4.50	5.99	5.24	5.95	5.55	5.75	93.99	91.87	92.93
V_2	RO-19	62.29	59.55	60.92	7.75	9.04	8.40	5.10	4.84	4.97	88.76	86.56	87.66
SEm±		0.94	0.71	0.54	0.29	0.26	0.16	0.15	0.15	0.13	0.26	0.39	0.23
CD(P=0.05)		5.75	4.32	3.31	1.78	1.59	1.00	….	….	….	1.56	2.35	1.38
B. Date of sowing													
D_1	Last week October	72.76	66.63	69.69	5.75	6.04	5.89	5.80	5.43	5.61	92.43	91.53	91.98
D_2	Second week November	66.82	64.91	65.86	6.06	7.03	6.54	5.55	5.16	5.36	91.49	90.20	90.84
D_3	Last week November	61.91	60.03	60.97	6.57	9.45	8.01	5.23	4.99	5.11	90.21	85.92	88.07
SEm±		1.92	0.99	1.16	0.09	0.08	0.07	0.20	0.10	0.09	0.32	0.08	0.19
CD(P=0.05)		7.55	3.89	4.57	0.35	0.30	0.28	….	….	….	1.27	0.33	0.73
C. Cutting management													
C_0	No cut seed to seed	69.18	64.14	66.66	6.14	7.48	6.81	5.47	5.14	5.30	91.67	89.38	90.53
C_1	One cut at 45 DAS + Seed	71.58	67.47	69.53	5.44	5.94	5.69	5.91	5.52	5.71	92.79	91.82	92.31
C_2	One cut at 60 DAS + Seed	60.73	59.95	60.34	6.79	9.10	7.95	5.20	4.93	5.06	89.66	86.44	88.05
SEm±		1.27	1.49	1.06	0.18	0.30	0.23	0.05	0.04	0.03	0.33	0.55	0.40
CD(P=0.05)		3.71	4.36	3.08	0.54	0.89	0.68	0.14	0.13	0.10	0.96	1.60	1.17
Interaction V X D X C		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Seed yield (q ha^{-1})

The data presented in Table 12 reveals that significantly influenced due to varieties, date of sowing and cutting managements during 2018-19 and 2019-20.

As regard to varieties, significantly highest seed yield was recorded under the variety JHO-822 (25.10 and 23.95 q ha^{-1} in 2018-19 and 2019-20) as compared to RO-19 during both the years and mean over the years. The mean seed yield was 24.52 q ha^{-1} which was 27.92% higher in variety JHO-822 over RO-19. This variability in different yield attributing characters was mainly due to their genetical behavior. These results are in close conformity with the findings of Lupingan *et al.* (1999) [11]; Naeem *et al*. (2002) [12] and Singh and Singh (1992) [13]. The overall improvement of crop growth reflected into better source-sink relationship, which in turn enhanced the yield attributes. The seed yield of crop had strong possible correlation with number of panicles per metre row length, weight of panicle, panicle length and test weight as reported by Kibite (1997) [14]; Lacko-Bortosova *et al.* (2000) [15] and Villasenor-Mir (2001) [16].

Among the date of sowing, significantly superior seed yield was recorded under the treatment when crop was sown last week of October (23.48 and 20.29 q ha^{-1} in 2018-19 and 2019-20) statistically significantly over crop was sown to last week of November but it was at par when crop was sown to second week of November during both the years and mean data. The higher seed yield with earlier sowing may be ascribed to better growth and development of the crop as indicated by corresponding increase in plant height, number of tillers, number of panicles, number of seeds panicle^{-1}, panicle weight to ultimate effect of seed production. Early sowing may be attributed to sufficient time available for the successful competition of both vegetative as well as reproductive phase of crop under the conducive environment condition. Sowing date is likely to change the plant environment including the climatic parameters like temperature, relative humidity, sunshine hours etc., the reasons for the superiority of early sowing are inherent in the effect of the environment on the growth and development of the crop plants. Similar results were also obtained by Joon *et al.* (1993) [17]. Cumulative effect of various yield contributing characters got culminated in higher seed yield in the early sowing date. Singh *et al.* (1993) [18] also recorded similar results.

Table 12: Seed yield, straw yield and harvest index of fodder oat as influenced by varieties, date of sowing and cutting management

Treatment		Seed yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index		
		2018-19	2019-20	Mean	2018-19	2019-20	Mean	2018-19	2019-20	Mean
A. Varieties										
V_1	JHO-822	25.10	23.95	24.52	95.12	93.49	94.30	20.98	20.57	20.77
V_2	RO-19	15.03	12.23	13.63	110.58	107.53	109.06	11.93	10.22	11.08
SEm±		0.67	0.30	0.38	0.94	0.96	0.95	0.47	0.39	0.35
CD(P=0.05)		4.07	1.82	2.33	5.74	5.83	5.77	2.85	2.36	2.16
B. Date of sowing										
D_1	Last week October	23.48	20.29	21.88	106.80	103.85	105.32	18.25	16.51	17.38
D_2	Second week November	20.81	18.50	19.65	103.44	101.60	102.52	17.00	15.63	16.32
D_3	Last week November	15.91	15.48	15.70	98.31	96.08	97.20	14.11	14.04	14.08
SEm±		0.99	0.50	0.61	1.02	1.43	1.21	0.64	0.47	0.43
CD(P=0.05)		3.90	1.96	2.39	4.02	5.60	4.75	2.52	1.84	1.70
C. Cutting management										
C_0	No cut seed to seed	20.22	18.72	19.47	122.66	120.24	121.45	14.04	13.38	13.71
C_1	One cut at 45 DAS + Seed	22.77	20.50	21.64	101.88	97.47	99.67	18.60	17.62	18.11
C_2	One cut at 60 DAS + Seed	17.20	15.05	16.13	84.02	83.83	83.92	16.72	15.18	15.95
SEm±		0.98	0.64	0.76	1.52	2.44	1.95	0.62	0.38	0.45

CD (P=0.05)	2.87	1.88	2.20	4.42	7.11	5.69	1.80	1.10	1.32
Interaction V X D X C	S	S	S	S	S	S	S	S	S

Table 13: Seed yield (q ha^{-1}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Seed yield (q ha^{-1})					
	2018-19					
	V$_1$: JHO-822			**V$_2$: RO-19**		
	D$_1$ Last week of October	**D$_2$ Second week of November**	**D$_3$ Last week of November**	**D$_1$ Last week of October**	**D$_2$ Second week of November**	**D$_3$ Last week of November**
C$_0$: No cut seed to seed	27.67	27.56	21.68	18.07	13.21	12.17
C$_1$: One cut at 45 DAS + seed	30.07	28.74	22.79	23.16	16.85	15.01
C$_2$: One cut at 60 DAS + seed	27.36	26.03	12.97	13.55	12.46	10.85
SEm±	0.88					
CD (P=0.05)	2.55					

Table 14: Seed yield (q ha^{-1}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Seed yield (q ha^{-1})					
	2019-20					
	V$_1$: JHO-822			**V$_2$: RO-19**		
	D$_1$ Last week of October	**D$_2$ Second week of November**	**D$_3$ Last week of November**	**D$_1$ Last week of October**	**D$_2$ Second week of November**	**D$_3$ Last week of November**
C$_0$: No cut seed to seed	27.27	23.21	23.08	14.96	12.68	10.10
C$_1$: One cut at 45 DAS + seed	29.68	28.28	23.41	15.80	14.97	10.88
C$_2$: One cut at 60 DAS + seed	22.30	21.79	15.53	10.74	10.07	9.90
SEm±	0.83					
CD (P=0.05)	2.41					

Table 15: Mean of seed yield (q ha^{-1}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Seed yield (q ha^{-1})					
	Mean					
	V$_1$: JHO-822			**V$_2$: RO-19**		
	D$_1$ Last week of October	**D$_2$ Second week of November**	**D$_3$ Last week of November**	**D$_1$ Last week of October**	**D$_2$ Second week of November**	**D$_3$ Last week of November**
C$_0$: No cut seed to seed	27.47	25.39	22.38	16.51	12.94	11.13
C$_1$: One cut at 45 DAS + seed	29.87	28.51	23.10	19.48	15.91	12.94
C$_2$: One cut at 60 DAS + seed	24.83	23.91	14.25	12.14	11.26	10.37
SEm±	0.63					
CD (P=0.05)	1.83					

As regarding to cutting management, significantly highest seed yield was recorded in the treatment when one cut was taken at 45 days after sowing and crop was left for seed production (22.77 and 20.50 q ha^{-1} in 2018-19 and 2019-20) as compared to other cutting managements *i.e.*, when one cut was taken at 60 days after sowing and crop was left for seed production and no cut seed to seed but it was at par with no cut seed to seed during both the years and mean over the years. Similar results were also reported by Sharma and Bhunia (2001) [19]. One cut was taken at 45 days after sowing and crop was left for seed production higher seed yield because early one cut at 45 days after sowing have more time for growth and produced more number of panicles per meter row length, higher number of seeds per panicle and higher 100 seed weight which reflected in higher seed yield. The lower seed yield in when one cut was taken at 60 days after sowing and crop was left for seed production may be due to poor regrowth/regeneration resulting in lower seed production.

The interaction among the varieties, date of sowing and cutting management was found significant with respect to seed yield during both the years and over mean data (Table 13 to 15). The significantly highest seed yield was obtained under the combination of variety JHO-822 X crop sown last week of October X when one cut was taken at 45 days after sowing and crop was left for seed production but it was at par with variety JHO-822 X when crop sown second week of November X when one cut was taken at 45 days after sowing and crop was left for seed production and variety JHO-822 X crop sown last week of October X when no cut seed to seed during both the experimental years and mean data.

Straw yield (q ha^{-1})

Straw yield of oat was considerably influenced due to varieties, date of sowing and cutting managements, during 2018-19 and 2019-20 are given in (Table 12).

Among the varieties, inverse relation was noticed between seed and straw yield *i.e.* with lesser seed yield the straw yield became higher. The straw yield significantly highest under the variety RO-19 (110.58 and 107.53 q ha^{-1} in 2018-19 and 2019-20) as compare to JHO-822. The variety RO-19 21.56% more straw yield against JHO-822 during mean over the years. Straw yield had a strong positive relationship with plant height and number of tillers meter length. These results are similar with the findings of Singh and Nanda (1998) [20] and Nazakat *et al.* (2004) [21].

Table 16: Straw yield (q ha^{-1}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Straw yield (q ha^{-1})					
	2018-19					
	V$_1$: JHO-822			**V$_2$: RO-19**		
	D$_1$ Last week of October	**D$_2$ Second week of November**	**D$_3$ Last week of November**	**D$_1$ Last week of October**	**D$_2$ Second week of November**	**D$_3$ Last week of November**
C$_0$: No cut seed to seed	120.73	119.00	118.38	127.27	126.25	124.33
C$_1$: One cut at 45 DAS + seed	87.70	86.35	86.15	125.79	117.33	107.93
C$_2$: One cut at 60 DAS + seed	84.33	82.83	70.60	95.00	88.87	82.47
SEm±	2.21					
CD (P=0.05)	6.46					

Table 17: Straw yield (q ha^{-1}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Straw yield (q ha^{-1})					
	2019-20					
	V$_1$: JHO-822			**V$_2$: RO-19**		
	D$_1$ Last week of October	**D$_2$ Second week of November**	**D$_3$ Last week of November**	**D$_1$ Last week of October**	**D$_2$ Second week of November**	**D$_3$ Last week of November**
C$_0$: No cut seed to seed	116.60	116.00	115.26	125.33	123.98	122.84
C$_1$: One cut at 45 DAS + seed	86.39	85.50	84.55	119.02	115.06	94.27
C$_2$: One cut at 60 DAS + seed	82.63	81.35	71.70	93.10	87.29	86.87
SEm±	2.76					
CD(P=0.5)	8.07					

Table 18: Mean of straw yield (q ha^{-1}) of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Straw yield (q ha^{-1})					
	Mean					
	V$_1$: JHO-822			**V$_2$: RO-19**		
	D$_1$ Last week of October	**D$_2$ Second week of November**	**D$_3$ Last week of November**	**D$_1$ Last week of October**	**D$_2$ Second week of November**	**D$_3$ Last week of November**
C$_0$: No cut seed to seed	118.67	117.70	116.30	126.30	125.12	123.59
C$_1$: One cut at 45 DAS + seed	87.05	85.93	85.35	122.40	116.20	101.10
C$_2$: One cut at 60 DAS + seed	83.48	82.09	71.15	94.05	88.08	84.67
SEm±	2.19					
CD (P=0.05)	6.39					

As regard to date of sowing significantly highest straw yield (106.80 and 103.85 q ha^{-1} in 2018-19 and 2019-20) was noted under the treatment when crop was early sown at last week of October as compared to other late sown dates second week of November and last week of November but it was at par with when crop was sown at second week of November during both the years and mean data Higher straw yield in oats in early sowing compared to late sowing which they attributed to availability of congenial temperature for better growth and development of crop at early stages and it could be due to more vegetative growth as reflected in plant height.

Among cutting management, significantly highest straw yield was recorded in the treatment when no cut seed to seed production (122.66 and 120.24 q ha^{-1} in 2018-19 and 2019-20) as compare to other treatments during both the years and mean over the years. Marcela *et al.* (2012) [22] also reported the similar results.

The interaction effect among varieties, date of sowing and cutting management was found significant with respect to straw yield during both the seasons and years and over mean data (Table 16 to 18). The significantly highest straw yield was recorded under the combination of variety RO-19 X crop sown at last week of October X with no cut seed to seed during both the experimental years and mean over the years but it was at par with variety Ro-19 X crop sown second week of November X when no cut seed to seed and variety RO-19 X crop sown at last week of October X when one cut was taken at 45 days after sowing and crop was left for seed production during both the years and mean over the years.

Harvest index

Data on harvest index significantly influenced due to variety, date of sowing and cutting managements, during 2018-19 and 2019-20 are present in Table 12.

Among the varieties significantly maximum mean harvest index was recorded under the variety JHO-822(20.77) as compare to variety RO-19 during both the years and mean over the years. Differences among varieties with regard to harvest index were due to differences in plant heights. Other researchers also observed significant differences among varieties with regard to harvest index due to variations in total dry matter accumulation (Dreccer *et al.* 2009) [23].

Table 19: Harvest index of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Harvest index					
	2018-19					
	V_1: JHO-822			V_2: RO-19		
	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November
C_0: No cut seed to seed	19.19	18.82	15.46	12.43	9.46	8.89
C_1: One cut at 45 DAS + seed	25.48	24.98	20.92	15.48	12.54	12.21
C_2: One cut at 60 DAS + seed	24.45	23.93	15.55	12.50	12.28	11.63
SEm±	0.59					
CD (P=0.05)	1.73					

Table 20: Harvest index of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Harvest index					
	2019-20					
	V_1: JHO-822			V_2:RO-19		
	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November
C_0: No cut seed to seed	19.52	16.65	16.56	10.32	9.28	7.59
C_1: One cut at 45 DAS + seed	25.58	24.89	21.70	11.71	11.53	10.33
C_2: One cut at 60 DAS + seed	21.27	21.13	17.79	10.56	10.30	10.27
SEm±	0.49					
CD (P=0.05)	1.44					

Table 21: Mean of harvest index of fodder oat as influenced by interaction between varieties, date of sowing and cutting management

	Harvest index					
	Mean					
	V_1: JHO-822			V_2: RO-19		
	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November	D_1 Last week of October	D_2 Second week of November	D_3 Last week of November
C_0: No cut seed to seed	19.36	17.74	16.01	11.41	9.37	8.24
C_1: One cut at 45 DAS + seed	**25.53**	24.94	21.31	13.59	12.03	11.27
C_2: One cut at 60 DAS + seed	22.86	22.53	16.67	11.54	11.29	10.95
SEm±	0.36					
CD (P=0.05)	1.05					

As regard to date of sowing significantly highest mean harvest index was found when crop was sown at last week of October (17.38) as compare to other sowing dates but it was at par with when crop was sown second week of November during both the years and mean over the years.

Regarding cutting management significantly maximum mean harvest index was noted in the treatment when one cut was taken at 45 days after sowing and crop was left for seed production (18.11) as compare to when no cut was taken and crop was left for seed production during both the years and mean data.

The interaction effect among varieties, date of sowing and cutting management was found significantly highest harvest index was under the combination of variety JHO-822 X crop sown date at last week of October X while one cut was taken at 45 days after sowing and crop was left for seed production but it was at par with variety JHO-822 X when crop sown second week of November X when one cut was taken at 45 days after sowing and crop was left for seed production during both the years and mean over the years (Table 19 to 21).

Conclusion

Significantly highest yield attributes and seed yield was recorded under the combination of oat variety JHO-822, when crop was sown at last week of October and one cutting was taken at 45 days after sowing and crop was left for seed production. Whereas, this combination was found at par with the combinations of variety JHO-822 and sowing at second week of November and one cut at 45 days after sowing and variety JHO-822 sown at last week of October with seed to seed where no cut was taken.

References

1. Anonymous. Forage crops and grasses. Handbook of Agriculture, ICAR, c2014.
2. Anonymous, USDA; c2019. http://apps.fas.usda.gov.
3. Kumar R. Crop technology demonstration an effective communication approach for dissemination of sustainable Green Gram production technology. Crop improvement. 2012;39:1583-1484.
4. Peterson DM, Wesenberg DM, Burrup DE, Erickson CA. Relationships among agronomic traits and grain composition in oat genotypes grown in different environments. Crop Science. 2005;45(4):1249-1255.
5. Singh JM, Nanda SS. Varietal reaction of fodder oat to yield, quality and cutting levels. Environment and-Ecology. 1998;16(2):365-367.
6. Malik P, Duhan BS, Midha LK. Effect of fertlizer application and cutting schedule on growth and yield

parameters in oat (*Avena sativa* L.). Forage Research. 2015;40(4):264-267.
7. Joshi YP, Singh V. Studies on the production potential and forage quality of different varieties of oats (*Avena sativa* L.). Forage Research. 1982;8(1):49-54.
8. Taneja KD, Gill PS, Solanki RK. Possibilities of taking fodder in addition to seed yield from barely and under different levels of nitrogen. Forage Research. 1981;7(1):31-38.
9. Baloch MSI, Nadim SMA, Khan MI, Khakwani AA. Effect of Seeding Density and Planting time on Growth and Yield Attributes of Wheat. J of Animal & Plant Science. 2010;20(4):239-240.
10. Ghosh DC. Influence of nitrogen, phosphorus and cutting on growth and yield of oat. Indian Journal of Production Agriculture. 1985;4(3):382-385.
11. Lupingan GS, Wang W, Qingfeng L, Jianping Y. An investigation of the high-yielding characteristics of oat Yumai No. 49. J Henan Agricultural. Science. 1999;8:8-9.
12. Naeem M, Khan MA, Chouhan MSM, Khan AH, Salah-ud-din S. Evaluation of different varieties of oats for green fodder yield potential. Asian Journal Plant Science. 2002;1(6):640-641.
13. Singh KA, Singh LN. Performance of oat varieties at mid hills of Sikkim. Indian Journal of Hill Farming. 1992;5(1):133-134.
14. Kibite S. Ac juniper. Oat. Canadian Journal. Plant Science. 1997;77(4):647-649.
15. Lacko-Bartosova M, Smolkova H, Galova Z, Scherer R. Quantitative factors and mineral composition of spelt oat varieties in southern Slovakia. Dinkelsorten candtechnik. 2000;55(2):116-118.
16. Villasenor-Mir HE, Espita-Ranges E, Margur-Gutier C. Registration of cevamex oat. Crop Sciences. 2001;41(1):266-267.
17. Joon RK, Yadav BD, Faroda AS. Effect of nitrogen and cutting management on grain production of multicut oat (*Avena sativa* L.). Indian Journal of Agronomy. 1993;38(1):19-21.
18. Singh Rohitashav, Sood BR, Sharma VK. Effect of cutting management and nitrogen levels of forage and seed yield of oat (*Avena sativa* L.) Forage Research. 1993;19(3&4):243-248.
19. Sharma SK, Bhunia SR, Yadava DK. Response of oat (*Avena sativa* L.) to cutting management, method of sowing and nitrogen. Forage Research. 2001;27(3):167-170.
20. Singh JM, Nanda SS. Varietal reaction of fodder oat to yield, quality and cutting levels. Environment and-Ecology. 1998;16(2):365-367.
21. Nazakat N, Abdul R, Zulifaqar A, Sarwar, Yousafi G. Performance of different oat (*Avena sativa* L.) varieties under the argon-climatic conditions of Bahawalpur-Pakistan. International Journal Agricultural & Bio. 2004;6(4):624-626.
22. Marcela AN, Castagnara DD, Paulo de Oliveira SR, De Oliveira E, Jobim CC, Tres TT, *et al*. IPR 126 white oat forage potential under free growth, cutting and grazing at two management heights. Brazilian Journal of Animal Science. 2012;41(4):889-897.
23. Dreccer MF, Herwaarden AF, Chapman SC. Grain number and grain weight in wheat lines contrasting for stem water soluble carbohydrate concentration. Field Crops Research. 2009;112(1):43-54.
24. Sharma N, Patterson PG. The impact of communication effectiveness and service quality on relationship commitment in consumer, professional services. Journal of services marketing. 1999, Apr 1;13(2):151-170