The Pharma Innovation Journal 2023; 12(10): 2119-2124

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 2119-2124

www.thepharmajournal.com
Received: 03-07-2023
Accepted: 08-08-2023

Digamber
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

RC Poonia
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

VS Mor
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Nidhi
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Rahul Kumar
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Sultan Singh
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Gagandeep Singh
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Digamber
Department of Seed Science & Technology, CCS Haryana Agricultural University, Hisar, Haryana, India

Fodder oat (*Avena sativa* L.) seed production: Date of sowing and cutting stubble height effect on seed yield and quality

Digamber, RC Poonia, VS Mor, Nidhi, Rahul Kumar, Sultan Singh and Gagandeep Singh

Abstract
The investigation was carried out to study the effect of date of sowing and cutting stubble height on Seed Yield and Quality. It is concluded that to produce quality seed of oat, the crop should be sown in early November. The maximum seed yield and better seed quality were found in normal date sown crop D_1 (6th November), whereas low seed yield and poor seed quality was found in very late sowing D_3 (2nd January). The cutting stubble heights have significantly affected the seed yield and quality of oat in case of dual (fodder + seed) crop of oat. The crop without cutting produced the highest yield and better quality seed. But for getting additional fodder yield along with better quality seed, foliage cut should be taken at stubble height of 10-15 cm. stubble height lesser than 10 cm increase the fodder yield a little but reduce the seed yield and quality significantly.

Keywords: Oat, sowing date, stubble height, seed quality

1. Introduction
Locally referred to as "Javi," oat (*Avena sativa* L.) is a crucial Rabi fodder crop that is often grown in irrigated settings in Northern and North-Western India. The most significant winter cereal fodder crop, oats are a rich supply of minerals like phosphorus, iron, and vitamin B1 as well as calories and protein. With a production of 35–40 tonnes of green fodder per hectare, oat is farmed on 1,000,000 hectares. It is mostly farmed in India's rabi season for fodder in the states of Uttar Pradesh, Punjab, Bihar, Haryana, and M.P. (Anonymous, 2014) [1]. The most important and affordable input in crop production, seed is essential to the advancement of agriculture. The type of seed used for planting determines the crop condition in a significant way. With minimal watering, it yields a very large amount of green fodder per unit area and per unit time. Oat fodder is often provided as green fodder, but it can also be made into silage or hay for use in the future when there is a shortage of fodder (Suttie and Reynolds, 2004) [22]. The response of various inputs in crop production is influenced by the type of seed that is sown. According to estimates, enhanced cultivars' better seeds can contribute to a 20–25% increase in output. This highlights the necessity of expanding the areas used to produce high-quality seeds. A variety of crop management techniques, including cutting management, sowing dates, nutritional spraying, fertilizer application, irrigation management, etc., are dependent on the production of high-quality seed. One of the key elements for growing high-quality seed is the sowing date. The supply of high-quality green fodder throughout the various winter and spring months can be improved by cultivating oats at the right sowing and harvesting times.

2. Materials and Methods
The study was conducted on oat variety HJ 8. Freshly harvested seeds were procured from Forage Section, Department of Genetics and Plant Breeding, the research was conducted in research farm area and laboratory of department of Seed Science & Technology CCS Haryana Agricultural University, Hisar. The sowing of oat was done at three different dates of sowing (Normal: 6 Nov. 2016 (D_1); Late: 2 Dec. 2016 (D_2); Very late: 2 Jan. 2017 (D_3) under recommended package and practices in a plot size of 5 m^2 (4.0 m x 1.25 m) with row to row spacing of 25 cm for each treatment in three replications by using factorial RBD. Cuttings were taken at four different stubble heights *i.e.* H_0 (no cutting), H_1 (zero cm), H_2 (5 cm), H_3 (10 cm) and H_4 (15 cm). Observations on flower per inflorescence, seed per inflorescence, ovule to

seed ratio, length of inflorescence (cm), seed yield(q/ha), 1000 seed weight, standard germination, seedling length (cm), seedling dry weight (mg), field emergence index, seedling establishment were recorded. Laboratory observation like seedling length, seedling dry weight, vigour index were recorded on the seeds harvested from the different treatments. For field emergence index, the number of seedlings emerged; were counted on each day and continued up to the seedling establishment and field emergence index also termed as the speed of emergence was calculated by the method as described by Maguire (1962) [9]. Seedling establishment (%) was determined by counting the total number of seedlings when the seedling emergence was completed or there was no further increase in total seedling emergence. Seedling length (cm) was calculated by measuring the root and shoot length after final count day. Standard germination (%) was calculated by counting the normal seedlings by testing samples in between paper method. Total number of flowers was counted in five plants and their average was taken as number of Flower per inflorescence per plant. For plant height calculation randomly five plants were selected and their average height was taken. Number of seeds per panicle was computed as the average number of seeds of five randomly taken panicles from the plot area at crop harvest. Statistical analysis of data was carried out by three-factor randomized complete block design combined over different sowing using OPSTAT. Fischer and Yates tables were consulted for comparison of 'F' values and 't' for determination of critical differences at 5% level of significance.

The meteorological data was obtained from Department of Agrometeorology, CCS Haryana Agricultural University, Hisar is situated between 29˚10́ North latitude and 75˚46́ East longitudes and 215.2 m above mean sea level. This tract is characterized by semi-arid climate, hot and dry winds during summer and dry severe cold in winter. The mean maximum and minimum temperature shows a wide range of fluctuation. The research trials were conducted at laboratory and research farm of the Seed Science and Technology department, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The field was in upland situation, irrigation facilities and proper drainage system were assured. The experimental site, having tropical hot and dry climate, is situated just north of Tropic of Cancer. Meteorological data on temperature (^{0} c), relative humidity (%), rainfall (mm) during the crop season is given in Fig. 1.

3. Results and Discussion

3.1 Growth and Yield Parameters

The data pertaining to various plant growth and yield parameters (plant height, Flower per inflorescence, Seed per inflorescence, Ovule to seed ratio, Length of inflorescence) are presented in Table 1, 2 and 3. A perusal of the data revealed that the foliage cuttings at different stubble heights significantly affect average plant height and maximum plant height (170.53 cm) was recorded in normal sowing when no cutting was taken followed by cutting taken at 15 cm stubble height (152.01 cm) and minimum plant height (139.98 cm) was recorded when cutting was taken at zero centimeter stubble height. In the overall sowing date mean irrespective of cuttings stubble height the normal date sown crop has the maximum plant height (147.63 cm) followed by late sowing (136.96 cm) and minimum average plant height in very late sowing *i.e.* 117.35 cm. Fodder cutting significantly affected the plant height as well as other characters. Irrespective of sowing dates Maximum average plant height (159.43 cm) was observed in without cutting treatment. It was followed by 15 cm stubble height treatment (138.72 cm) and 10 cm stubble height treatment (138.04 cm). Minimum mean plant height (126.18 cm) was observed in the treatment of zero centimeter stubble height.

The number of flower per inflorescence was significantly affected by date of sowing as well as cutting stubble height. The overall maximum (76.50) number flower per inflorescence was found in no cutting treatment in normal sown crop. The overall mean number of flower per inflorescence irrespective of cutting stubble height was found in normal (67.27) date sowing followed by late (53.52) and very late (42.03). The overall cutting stubble height mean irrespective of sowing date showed that the maximum (67.33) number of flower per inflorescence was found in no cutting treatment. It increased gradually as the cutting stubble height was increased *i.e.* zero cm (45.38), 5 cm (52.84), 10 cm (59.30) and 15 cm (59.57). The results were in accordance with Malik and Babli (2017) [10], Hussain *et al.,* (2004) [5] and Singh *et al.,* (1985) [20], Kevyan (2010) [7]. (Table 1)

The number of seed per inflorescence is a direct factor which affects the seed yield. Maximum number of seeds per inflorescence (72.60) were obtained in normal sowing no cutting treatment. The overall maximum number of seeds per inflorescence irrespective of cutting were obtained in normal sowing (58.43) which decreased to 47.50 in late and 33.87 in very late. The cutting stubble height mean irrespective of sowing date depicted that number of seeds per inflorescence were maximum (60.76) in no cutting treatment and minimum in zero centimetre stubble cutting height treatment. The number of seeds per inflorescence decreased as the cutting stubble height was reduced from 15 cm to zero centimeter. The results were in conformity with that of the findings of Prasad and Mukherji (1988) [17]. (Table 2)

Ovule to seed ratio is a directly associated character with seed yield. The overall maximum (0.949) ovule to seed ratio was found in normal sown crop without cutting treatment. The average maximum ovule to seed ratio (0.890) irrespective of cutting stubble height was found in normal date sown crop and it decreased in late (0.880) and very late sown (0.810) crop. The overall mean of cutting stubble heights irrespective of sowing date was showed that the maximum (0.895) ovule to seed ratio was found in treatment in which no cutting was taken which was followed by 10 cm stubble height treatment (0.890) and 15 cm stubble cutting height treatment (0.884). It decreased to 0.835 in 5 cm cutting stubble height treatment and 0.821 in zero centimetre cutting height treatment. The results are according to the findings of Taneja *et al*., (1981) [23]. (Table 2)

Overall maximum Length of inflorescence (44.20 cm) was found in treatment of normal date of sowing in which no cutting was taken. Irrespective of cutting stubble height maximum overall mean of Length of inflorescence was found in normal date (35.27 cm) sown crop. It decreased with delay in date of sowing. It was minimum (23.03 cm) in very late sown crop. Irrespective of sowing date maximum Length of inflorescence (35.93 cm) was recorded in no cutting treatment. It reduced to 31.38 cm in 15 cm stubble height treatment and 31.38 cm in 10 cm stubble height treatment. The minimum Length of inflorescence was found in the treatment in which cutting was taken at zero cm stubble

height. Similar findings were obtained by Midha *et al.,* (1999) [25] and Mojaddam and Nouri, (2014) [14] in a research conducted on oat crop. (Table 3)

Maximum seed yield (19.00q) was obtained in no cutting treatment of normal sowing. Irrespective of cutting stubble height maximum seed yield was obtained in normal date sowing. It reduced to 29.68q in late and 23.03q in very late sowing. The overall seed yield reduced in the treatment in which cutting were taken. There was a gradual decrease in treatment in which cutting was taken at a lesser stubble height. Irrespective of sowing date the maximum seed yield (14.49q) was obtained from no cutting treatment. It reduced to 10.14q in 15 cm stubble height treatment and 10.01q in 10 cm stubble height treatment. The minimum seed yield was obtained from zero cm stubble height treatment. The results were similar to the findings of Verma *et al.,* (1997) [24], Patil *et al.,* (1993) [16] and Khalil *et al.,* Avtar *et al.* (2011) [8]. (Table 3)

3.2 Seed Quality parameters

The overall maximum test weight was found (32.58g) in controlled plot of normal sowing. Irrespective of cutting treatment overall maximum average test weight (28.94g) was found in no cutting treatment. It decreased to 28.42g in late and 24.06g in very late sowing. The overall mean test weight irrespective of sowing date decreased as the stubble height reduced from 15 cm to zero cm. It was maximum (29.66g) in no cutting treatment and minimum (24.95g) in zero cm stubble height treatment. The test weight of 15 cm stubble height treatment (27.89g) and 10 cm stubble height treatment (28.26 g) were found significantly at par with each other. (Table 4)

Germination percentage (standard germination) was maximum (96.00%) in no cutting treatment of normal sowing. Irrespective of cutting treatment it was found maximum (90.78%) in normal sowing. It decreased to 82.49 per cent in late sowing and 48.83 per cent in very late sowing. Irrespective of sowing date overall maximum mean germination percentage (86.67%) was found in no cutting treatment. The minimum germination percentage (65.92%) was found in zero cm cutting stubble height treatment. The effect of sowing date and cutting stubble height was found significant *w.r.t.* normal sowing and no cutting treatment respectively. The trend of test weight was in accordance with that of Karwasra *et al.* (2007) [6] while Malik *et al.,* 2015 [11] reported that there was not much difference in test weight in treatments of cutting of 50 and 70 DAS which contradicts the above study. (Table 4)

The maximum seedling length (41.23 cm) was found in normal sowing no cutting treatment. The maximum mean seedling length (38.97 cm) irrespective of cutting treatment was observed in normal date sowing. It was followed by late (36.28 cm) and very late sowing (30.24 cm). Irrespective of sowing date maximum mean seedling length (38.40 cm) was observed in no cutting treatment. The seedling length reduced gradually as the stubble height reduced from 15 cm to 0 cm. It was found 36.44 cm and 36.39 cm for 10 cm and 15 cm stubble height cutting treatment respectively. Zero cm cutting stubble height treatment recorded the minimum seedling length of 32.55 cm. (Table 5)

Seedling dry weight is a parameter for the evaluation of quality of seed. The maximum seedling dry weight was found in without cutting in normal sowing. Irrespective of cutting stubble height the maximum mean seedling dry weight (302.50mg) was found in normal date sowing. The seedling dry weight decrease gradually as the sowing time stretched too late and very late. It was found 267.50 mg, 190.00 mg in late and very late sowing respectively. Irrespective of sowing date maximum seedling dry weight (300mg) was obtained in no cutting treatment. It was found 276.67 mg, 273.33mg, 250 mg and 213.33 mg in 15 cm, 10 cm, and 5 cmand zero centimeter cutting stubble height respectively. Thakral *et al.* (1993) [26] and Sreelatha *et al.,* (1997) [21] in their research obtained the results that are similar with the above findings. (Table 5)

Vigour Index is the direct indicator of seed quality. The maximum vigour Index-I (3957) was found in no cutting treatment in normal date sowing. The maximum mean vigour Index-I (3542.70) irrespective cutting height treatment was found in normal date of sowing, it decreased to 3021 in late and 1544.75 in very late sowing treatment. Irrespective of sowing date the maximum (3366) overall mean vigour index-I was found in without cutting treatment. It decrease to 2965 and 2951.33 in 15 cm and 10 cm cutting height treatment. Minimum vigour Index-I (2235.33) was observed in 0 cm cutting height treatment. Vigour indices result was in conformity with that of the findings of Sharma *et al.,* (2001) [19] and Patel (2003) [15]. (Table 6)

The maximum vigour Index-II (1015) was found in no cutting treatment in late sowing. The maximum mean vigour Index-II (918.75) irrespective cutting height treatment was found in normal date of sowing, it decreased to 740.25 in late and 330.75 in very late sowing treatment. Irrespective of sowing date the maximum (867) overall mean vigour index-I was found in without cutting treatment. It decrease to 758 and 750.67 in 15 cm and 10 cm cutting height treatment. Minimum vigour Index-II (510.67) was observed in 0 cm cutting height treatment. Vigour indices result was in conformity with that of the findings of Singh *et al.,* (2014) [27] and Shaikh *et al.,* (2004) [18]. (Table 6)

Field emergence index being a parameter for the quality evaluation of seed, it was found maximum (5.5) in controlled treatment of normal date sown crop. The maximum overall mean Field emergence index (4.43) was found in controlled treatment irrespective of sowing date. The Field emergence index decrease gradually as the cutting height reduced from 15 cm to 0 cm. It was found 4.39, 4.34, 4.30 and 4.26 in 15 cm 10 cm, 5 cm and 0 cm respectively. Irrespective of cutting height the maximum Field emergence index was found in the normal date sown crop (5.37) which decreased to 4.34 in late and 3.25 in very late sowing. (Table 7)

Seedling establishment was maximum (82%) in all treatments was maximum in normal date sown controlled treatment. Highest mean seedling establishment among sowing dates irrespective of cutting height treatment was maximum (71.80%) in normal date sown crop. It decreased to 21.44% and 19.22% in late and very late sowing respectively. Overall mean Seedling establishment among cutting height treatment irrespective of sowing date was maximum (74.33%) in controlled treatment. It decreased to 61.70%, 61.70% and 55.40% in 15 cm, 10 cm and 5 cm cutting height treatment respectively. The minimum Seedling establishment was found in treatment of 0 cm stubble height. The findings were in accordance with that of Bali *et al.* (1998) [3] and May *et al.* (2004) [12]. (Table 7)

Table 1: Effect of date of sowing and cutting stubble height on plant height at maturity and flower per inflorescence

Plant height at maturity					Flower per inflorescence			
Stubble height	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**
No cutting	170.53	161.73	146.03	159.43	76.50	69.20	56.30	67.33
0 cm	139.98	127.94	110.63	126.18	56.77	42.51	36.87	45.38
5 cm	147.07	136.00	115.83	132.97	66.9	51.13	40.5	52.84
10 cm	151.46	141.56	121.11	138.04	72.6	60.17	45.13	59.30
15 cm	152.01	142.33	121.83	138.72	72.8	60.27	45.63	59.57
Mean	147.63	136.96	117.35	133.98	67.27	53.52	42.03	54.27
CD@5%	D=0.545, H=0.629, D × H=1.09				D=0.611, H=0.706, D × H=1.223			

Table 2: Effect of date of sowing and cutting stubble height on seed per inflorescence and ovule to seed ratio

Seed per inflorescence					Ovule to seed ratio			
Stubble height	**Normal sowing**	**Late sowing**	**Very late sowing**	Mean	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**
No cutting	72.60	64.20	45.48	60.76	0.949	0.928	0.808	0.895
0 cm	47.05	36.08	28.43	37.19	0.840	0.847	0.775	0.821
5 cm	54.92	44.33	32.4	43.88	0.855	0.850	0.799	0.835
10 cm	66.33	54.73	37.18	52.75	0.935	0.910	0.825	0.890
15 cm	65.42	54.87	37.47	52.59	0.920	0.909	0.822	0.884
Mean	58.43	47.50	33.87	46.60	0.89	0.88	0.81	0.86
CD@5%	D=0.541, H=0.625, D × H=1.082				D=0.014, H=0.017, D × H= NS			

Table 3: Effect of date of sowing and cutting stubble height on length of inflorescence and seed yield (q/ha)

Length of inflorescence					Seed yield (q/ha)			
Stubble height	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**
No cutting	44.20	35.40	28.20	35.93	19.00	17.07	7.40	14.49
0 cm	31.00	25.32	20.09	25.47	8.60	6.40	3.20	6.07
5 cm	35.07	29.86	21.93	28.95	11.53	9.80	4.27	8.53
10 cm	37.48	31.70	24.97	31.38	14.31	10.91	4.80	10.01
15 cm	37.53	31.82	25.13	31.49	14.26	11.20	4.96	10.14
Mean	35.27	29.68	23.03	29.33	12.18	9.58	4.31	8.69
CD@5%	D=0.722, H=0.834, D × H= NS				D=0.393, H=0.454, D × H=0.786			

Table 4: Effect of date of sowing and cutting stubble height on 1000 seed weight (test weight) and standard germination

1000 seed weight (test weight)					Standard germination			
Stubble height	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**
No cutting	26.54	29.86	32.58	29.66	96.00	93.33	70.67	86.67
0 cm	29.04	26.31	19.51	24.95	84.22 (66.65)	77.11 (62.45)	36.44 (37.10)	65.92 (55.40)
5 cm	29.6	28.61	24.16	27.46	91.56 (73.21)	80.44 (64.65)	47.33 (43.44)	73.11 (60.43)
10 cm	29.59	29.41	25.79	28.26	93.33 (75.55)	86.22 (68.87)	58.22 (49.78)	79.25 (64.73)
15 cm	27.54	29.33	26.79	27.89	94.00 (76.15)	86.22 (68.87)	59.33 (50.45)	79.85 (65.16)
Mean	28.94	28.42	24.06	27.14	90.78 (72.89)	82.49 (66.21)	48.83 (45.19)	77.57 (61.43)
CD@5%	D=0.449, H=0.518, D × H=0.897				D=1.282 (1.11), H=1.481(1.28), D × H=2.564(2.22)			

Table 5: Effect of date of sowing and cutting stubble height on seedling length and seedling dry weight (mg)

Seedling length					Seedling dry weight (mg)			
Stubble height	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**
No cutting	41.23	40.31	33.67	38.40	330	310	250	300
0 cm	37.90	31.99	27.76	32.55	280	230	130	213.33
5 cm	39.30	36.35	30.18	35.28	290	260	200	250.00
10 cm	39.52	38.33	31.47	36.44	320	290	210	273.33
15 cm	39.17	38.44	31.55	36.39	320	290	220	276.67
Mean	38.97	36.28	30.24	35.16	302.50	267.50	190.00	253.33
CD@5%	D=0.303, H=0.35, D × H= 0.606				D=7.213, H=8.329, D × H=14.427			

Table 6: Effect of date of sowing and cutting stubble height on vigour Index-I and vigour Index-II

Vigour Index-I					Vigour Index-II			
Stubble height	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**
No cutting	3957	3762	2379	3366	991	1015	594	867
0 cm	3198	2494	1014	2235.33	770	605	157	510.67
5 cm	3600	2942	1437	2659.67	900	705	296	633.67
10 cm	3691	3319	1844	2951.33	998	825	429	750.67
15 cm	3682	3329	1884	2965.00	1007	826	441	758.00
Mean	3542.7	3021.00	1544.75	2702.83	918.75	740.25	330.75	663.25
CD@5%	D=47.352, H=54.678, D × H= 94.704				D=23.525, H=27.164, D × H= NS			

Table 7: Effect of date of sowing and cutting stubble height on field emergence Index seedling establishment (%)

Field emergence Index					Seedling establishment (%)			
Stubble height	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**	**Normal sowing**	**Late sowing**	**Very late sowing**	**Mean**
No cutting	5.5	4.41	3.38	4.43	82.00	79.00	62.00	74.33
0 cm	5.32	4.3	3.16	4.26	67.33 (55.13)	21.44 (51.67)	19.22 (25.61)	49.33 (44.14)
5 cm	5.36	4.33	3.21	4.30	71.33 (57.62)	66.55 (54.73)	28.33 (32.00)	55.40 (48.12)
10 cm	5.4	4.37	3.26	4.34	74.00 (59.34)	71.44 (57.71)	39.66 (38.95)	61.70 (52.00)
15 cm	5.41	4.37	3.38	4.39	74.55 (59.72)	71.55 (57.77)	39.00 (38.55)	61.70 (52.01)
Mean	5.37	4.34	3.25	4.32	71.80 (57.95)	21.44 (51.67)	19.22 (25.61)	49.33 (44.14)
CD@5%	D=0.008, H=0.01, D × H=0.017				D=0.709 (0.45), H=0.819(0.522), D × H=1.419(0.903)			

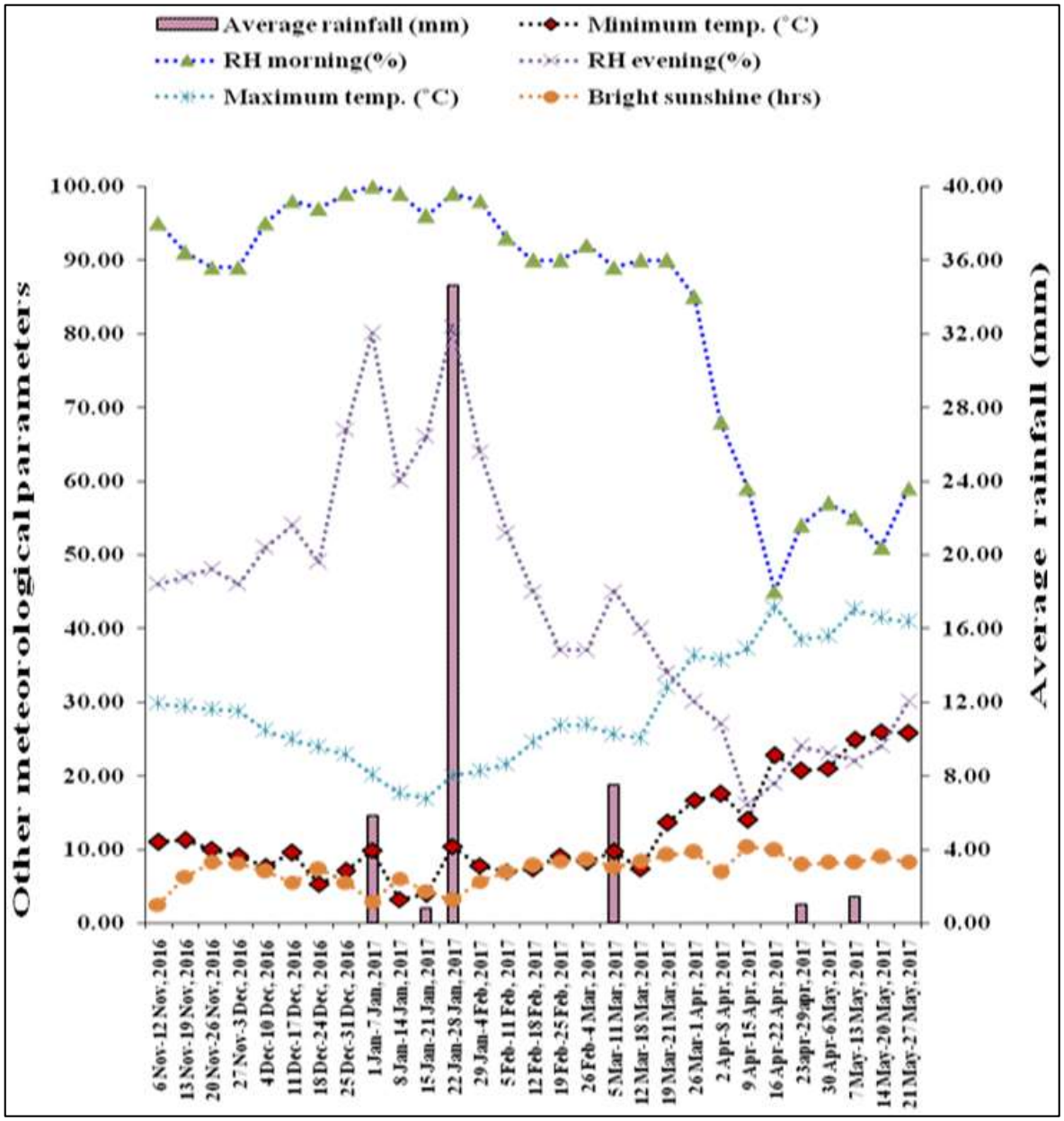

Fig 1: Average meteorological data on temperature (^{0} c), relative humidity (%), rainfall (mm) during the crop season

Acknowledgement

I would like to acknowledge my indebtedness and render my warmest thanks to my supervisor Dr. R.C. Poonia, who made this work possible. His friendly guidance and expert advice have been invaluable throughout all stages of the research work. I would also wish to express my gratitude to my co-advisor Dr. V.S. Mor for extended discussions and valuable suggestions which have contributed greatly to the improvement of the research. The article has also benefited from the suggestions of my colleague Dr. Nidhi and juniors Rahul kumar & Gagandeep Singh. I take this opportunity to thank them.

Conclusion

The date of sowing and stubble height has significantly affected the seed yield and quality of oat in case of dual (fodder + seed) crop of oat. The stubble height at foliage cutting should be maintained approximately 10 cm from the

ground level to avoid the great reduction of seed yield and quality. No cutting has been recommended in case of very late D_3 (2^{nd} January) sown oat crop for seed production.

References

1. Anonymous. Forage crops and grasses. Handbook of Agriculture, ICAR; c2014.
2. Avtar S, Hadda MS, Bhambota VK. Forage yield and quality of oat varieties under multicut forage production system. Indian Journal of Ecology. 1990;17(1):67-68.
3. Bali AS, Bali AS, Shah MH. Performance of different oat (*Avena sativa* L.) cultivars to cutting management and planting dates in rice-oat cropping system. Forage Research. 1998;24(3):169-170.
4. Dost M. End of Assignment report on fodder component. UNDP/FAO project PAK/86/027. FAO/UNDP, Gilgit, Pakistan; c1997.
5. Hussain A, Khan S, Mohammad D. Clipping of oats at various intervals on herbage yield, forage quality and seed yield. Pakistan Journal of Agriculture Research. 2004;18(1):72-75
6. Karwasra RS, Kumar V, Kumar A, Kumar A. Integrated nutrient and cutting management. Forage Research. 2007;33(1):63-64.
7. Keyvan S. The effect of sowing date and row spacing on yield and yield components on Hashem chickpea variety under rainfed condition. African Journal of Biotechnology. 2010;9(1):007-011.
8. Khalil SK, Khan F, Rehman A, Muhammad FIDA, Amanullah KA, Shah MK, *et al*. Dual-purpose wheat for forage and grain yield in response to cutting, seed rate and nitrogen. Pakistan Journal of botany. 2011;43(2):937-947.
9. Maguire JD. Speed of germination-aid in selection and evaluation for seedling emergence and vigor. Crop Science. 1962;2:176-177.
10. Malik, Babli. Effect of Various Cutting Management Schedule in Oat Crop. International Journal of Current Microbiology and Applied Sciences. 2017;6(12):843-846.
11. Malik P, Duhan BS, Midha LK. Effect of fertilizer application and cutting schedule on growth and yield parameters in oat (*Avena sativa* L.). Forage Research. 2015;40:264-267.
12. May WE, Mohr RM, Lafond GP, Johnston AM, Stevenson FC. Early seeding dates improve oat yield and quality in the eastern prairies. Canadian Journal of Plant Science. 2004;84(2):431-442.
13. Midha LK, Panwar KS, Sharma NK. Effect of cutting frequency and time of Nitrogen Application on yield & Quality of Oat. Forage Research. 1994;25:99-102.
14. Mojaddam M, Nouri A. The effect of sowing date and plant density on yield and yield components of cowpea. 2014;4(3):461-467.
15. Patel JR. Effect of sowing dates on fodder yield of different crops during winter season. Journal-Maharashtra agricultural universities. 2003;28(2):181-181.
16. Patil SK, Pisal AA, Khot RB, Desale JS. Seed-production potential of oat (*Avena-sativa*) as influenced by cutting management and nitrogen. Indian journal of Agronomy. 1993;38(3):389-391.
17. Prasad LK, Mukerji SK. Effect of sowing time and stage of cutting on the herbage yield and subsequent seed production of oat. Seed Research. 1988;16(2):218-221.
18. Shaikh AK, Munde PR, Jadav KT, Suryawanshi VP, Suryavanshi SB, Wal GR, *et al*. Effect of sowing date and row spacing on growth and yield of forage oat (*Avena sativa*). Journal of Soils and Crops. 2004;14(1):137-141.
19. Sharma SK, Bhunia SR. Response of oat (*Avena sativa*) to cutting management, method of sowing and nitrogen. Indian Journal of Agronomy. 2001;46(3):563-567.
20. Singh V, Khoker JS, Joshi YP, Verma SS. Response of forage oat to sowing Dates and cutting management on seed production. Forage Research. 1985;11(1):45-49.
21. Sreelatha D, Rao KL, Veeraraghavaiah R, Padmaja M. Physiological variations in French bean (*Phaseolus vulgaris* L.) cultivars as affected by sowing dates. Annals of Agricultural Research. 1997;18:111-114.
22. Suttie JM, Reynolds SG. (Eds.). Fodder oats: A world overview (No. 33). Food & Agriculture Organization; c2004.
23. Taneja KD, Gill PS, Solanki KR. Possibility of taking fodder in addition to seed from barley (*Hordeum vulgare* L.) and oats (*Avena sativa*) under different levels of nitrogen. Forage research; c1981.
24. Verma SS, Singh V, Joshi YP. A short note on the seed production of wheat (VL 616) and oat (UPO-94) under different Cutting management. Forage Research. 1997;22(4):295-297.
25. Singh SK, Dattatrayam RS, Shapiro NM, Mandal P, Pacheco JF, Midha RK, *et al*. Crustal and upper mantle structure of Peninsular India and source parameters of the 21 May 1997, Jabalpur earthquake (Mw= 5.8): Results from a new regional broadband network. Bulletin of the Seismological Society of America. 1999;89(6):1631-1641.
26. Mittal RL, Sekhon AS, Singh G, Thakral H. The prevalence of congenital orthopaedic anomalies in a rural community. International orthopaedics. 1993;17:11-12.
27. Singh S, Prasad SM. Growth, photosynthesis and oxidative responses of *Solanum melongena* L. seedlings to cadmium stress: mechanism of toxicity amelioration by kinetin. Scientia Horticulturae. 2014;176:1-0.