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Effect of sowing windows and cutting management on growth and seed yield of oat (*Avena sativa* L.)

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Abstract
A field experimentation was undertaken during *Rabi* 2021 at Research farm PGI, Mahatma Phule Krishi Vidyapeeth, Rahuri to study the Effect of sowing windows and cutting management on green forage and seed yield of oat (*Avena sativa* L.). The outcome of this research revealed that maximum growth, yield and yield attributing characters and Economics of oat crop were recorded with sowing crop at 46th MW and cutting for fodder at 50 DAS.

Keywords: Sowing windows, cutting management, economics, oat

Introduction
Oats (*Avena sativa* L.) is an important winter cereal crop in north-western regions of India due to congenial climate for this crop owing to its excellent growth habit and high nutritive value for all types of livestock, so its popularity as fodder crop is increasing. The oat crop is known to have high yielding potential and multicut ability because of its excellent regeneration character.

The worldwide production of oat was 25 million tonnes in the year 2020. The countries leading in oat production are Canada, Russia, Poland, Spain, Finland, Australia and the United Kingdom (Anonymous, 2022) [2]. In India, it is grown for fodder in north-western part of the country *viz*. Punjab, Haryana, Uttar Pradesh, Uttaranchal, some parts of Madhya Pradesh, Himachal Pradesh, Maharashtra, Orissa, Gujrat, Bihar and West Bengal. The most important cultivated species of oat is *Avena sativa* L. covering about 80% of total world acreage.

Oat provides soft and palatable fodder. The chemical composition of green fodder varies with the stage of harvest. When harvested at 50% flowering stage of plants, its green fodder on dry matter basis contains 10.0-11.5% CP, 55-63% NDF, 30-32% ADF, 22.0-23.5% cellulose and 17-20% hemicellulose. Oat is also used as straw, hay or silage. Its grain makes a good feed particularly for horses, sheep and poultry. Oats is the most important cereal fodder crop grown in the winter season in the north, western and central India and now extending to the eastern region. Oat requires a long and cool season for its growth; therefore, it is successfully grown in the plains and hilly areas of the country. Oat is well adapted to cooler environment. Its optimum growth is attained in sites with 15-25°C temperature in winter with moist conditions. Although, it can tolerate frost up to some extent but its fodder yield and quality is reduced due to hot and dry conditions.

Oat is ranked around sixth in world cereal production following wheat, maize, rice, barley and sorghum. Oat grain has always been an important for livestock feed. They are the good source of protein, fibre and minerals. In many parts of the world oats are grown for use as grain as well as forage and fodder straw for bedding, hay, haylage, silage & chaff. Livestock grain feed is still the primary use of oat crops. Oats are better adapted to variable soil types and can perform better on acid soils than other small grain cereal crops.

Oat is a winter fodder, mostly fed as green but surplus is converted into silage or hay to use during fodder deficit periods. Oat as forage crop has the winter hardy and serves as catch crop. It is preferred feed of all animals and its straw is soft and grain is also valuable feed for horses, dairy cows, poultry and young breeding animals. Oat protein is nearly equivalent in quality to soy protein, which has been shown by the World Health Organization to be equal to meat, milk and egg protein. The farmers face fodder deficiency in winter when they have only dry stalks of summer cereal fodders or dry summer grasses.

Time of sowing is one of the important yield contribution factors, which is largely governed by temperature. It has been observed that the yield is adversely affected under very early and late sown condition. As oat crop is generally sown in the month of October and November so fodder yield varies considerably owing to difference in temperature during growing season. Date of cutting oat crop for fodder is another production factor within the control of grower. Cutting very young crop as fodder gives lower fodder yield of superior quality than cutting at advanced stage.

Materials and Methods

Experimental site and soil

A field experiment was conducted at the Research farm, PGI, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar during *Rabi* season of 2021-22. The soil in the experimental field belongs to Inceptisol order, and its texture is silty clay with a depth of more than 60 cm, and the topography is uniform and levelled. For the assessment of initial soil fertility status, representative initial soil samples were taken. These soil samples were properly mixed, and a composite soil sample was created and evaluated for physical and chemical soil parameters. The soil is low in available nitrogen (169.18 kg ha^{-1}), medium in available phosphorus (17.68 kg ha^{-1}) and very high in available potassium (382.59 kg ha^{-1}). In reaction, the soil in the experimental field was mildly alkaline (pH 7.5) with 0.48% organic carbon, soil electrical conductivity was 0.29 dSm^{-1}.

Experimental design and Treatments

The experiment was laid out in split plot design with three replications and containing 3 Main plot treatments *Viz*., S_1: Sowing at 42nd MW (15th- 21st October), S_2: Sowing at 44th MW (29th October- 4th November), S_3: Sowing at 46th MW (12th- 18th November) and sub plot treatments *Viz*., C_1: No cut for fodder and left for seed only, C_2: Cut at 40 DAS for fodder and left for seed, C_3: Cut at 50 DAS for fodder and left for seed, C_4: Cut at 60 DAS for fodder and left for seed . Oat variety Phule harita (RO-19) was used with recommended package of practices. Oat seeds were sown solid row planting at the rate of 100 kg ha^{-1} with 30 cm row to row spacing and at a depth of 2-3 cm.

Results and Discussion

The growth and yield attributes are significantly influenced by sowing windows and cutting management at harvest. Crop sown at 46th MW and no cutting for fodder treatment showed significantly taller plants (131.12 cm), more number of functional leaves (2.78), higher leaf area per plant (1.48 dm^2)and the highest dry matter accumulation (42.06 g $plant^{-1}$) at harvest and as far the yield attributes are concerned the parameters such as panicle length (27.34 cm), number of seeds per panicle (45.92) and 1000 grain weight (33.58 g) and seed weight per panicle (2.24 g) were also significantly the highest in treatment comprised of sowing on 46th MW (main plot factor) and no cutting for fodder (subplot factor). Significance of growth and yield parameters in 46th MW sowing window might be due to availability of optimum temperature, suitable photoperiod and relative humidity which helps in better growth of plants through enhanced cell division, thus aids in internodal elongation. (Shaik *et al*. 2004; Roy *et al*. 2005 and Alam *et al*. 2007) [8, 7, 1]. No cutting for fodder and left for seed only treatment performance was better as compared to other treatments, it might be due to the fact that no cut plot received continuous long growth period as compared to 40, 50 and 60 DAS treatments which contributed to higher growth and yield attributing characters (Patel and Alagundgi 2013; Singh *et al*. 2014; Laxman 2016; Digamber *et al*. 2020 and Singh *et al*. 2020) [6, 10, 3, 9].

Table 1: Growth attributes of oat as influenced by sowing windows and cutting management.

Treatment	Plant height (cm)	Number of functional leaves $plant^{-1}$	Leaf area $plant^{-1}$	Dry matter production $plant^{-1}$
A) Main plot (Sowing windows-3)				
S_1-Sowing at 42nd MW (15-21 October)	125.63	2.52	1.28	37.08
S_2-Sowing at 44th MW (29 Oct- 4 Nov.)	128.19	2.62	1.37	39.97
S_3-Sowing at 46th MW (12-18 Nov.)	131.12	2.78	1.48	42.06
S.E.m±	0.80	0.05	0.03	0.69
C.D.at 5%	3.14	NS	0.10	2.74
B) Sub plots (Cutting management- 4)				
C_1- No cutting for fodder and left for seed only	146.52	1.89	1.11	46.84
C_2- Cut at 40 DAS for fodder and left for seed	133.18	2.47	1.21	41.54
C_3- Cut at 50 DAS for fodder and left for seed	125.62	2.80	1.50	37.51
C_4- Cut at 60 DAS for fodder and left for seed	107.93	3.40	1.69	32.92
S.E.m±	2.86	0.09	0.04	1.09
C.D. at 5%	8.51	0.28	0.11	3.23
C) Interaction (S × C)				
Between two subplots means at same level of main plot mean				
S.E.m±	4.96	0.16	0.07	1.88
C.D.at 5%	NS	NS	NS	NS
Between two main plots means at same level of sub plot mean				
S.E.m±	4.37	0.15	0.06	1.77
C.D. at 5%	NS	NS	NS	NS
CV %	6.70	10.77	8.34	8.20
General mean	128.31	2.64	1.38	39.70

Table 2: Yield attributes of oat as influenced by sowing windows and cutting management.

Treatment	Panicle length (cm)	Number of seeds panicle^{-1}	1000 grain weight (g)	Seed weight panicle^{-1} (g)
A) Main plot (Sowing windows-3)				
S_1-Sowing at 42nd MW (15-21 October)	25.50	42.67	30.00	2.10
S_2-Sowing at 44th MW (29 Oct- 4 Nov.)	26.88	44.67	32.08	2.17
S_3-Sowing at 46th MW (12-18 Nov.)	27.34	45.92	33.58	2.24
S.E.m±	0.36	0.54	0.59	0.03
C.D.at 5%	1.42	2.11	2.31	0.10
B) Sub plots (Cutting management-4)				
C_1- No cutting for fodder and left for seed only	29.25	50.11	34.78	2.28
C_2- Cut at 40 DAS for fodder and left for seed	27.46	46.00	32.11	2.19
C_3- Cut at 50 DAS for fodder and left for seed	25.85	42.22	31.22	2.16
C_4- Cut at 60 DAS for fodder and left for seed	23.73	39.33	29.44	2.06
S.E.m±	0.94	1.48	1.11	0.05
C.D.at 5%	2.79	4.40	3.30	0.15
C) Interaction (S × C)				
Between two subplots means at same level of main plot mean				
S.E.m±	1.63	2.56	1.93	0.08
C.D.at 5%	NS	NS	NS	NS
Between two main plots means at same level of sub plot mean				
S.E.m±	1.46	2.28	1.77	0.08
C.D.at 5%	NS	NS	NS	NS
CV %	10.61	10.00	10.46	6.78
General mean	26.57	44.42	31.89	2.17

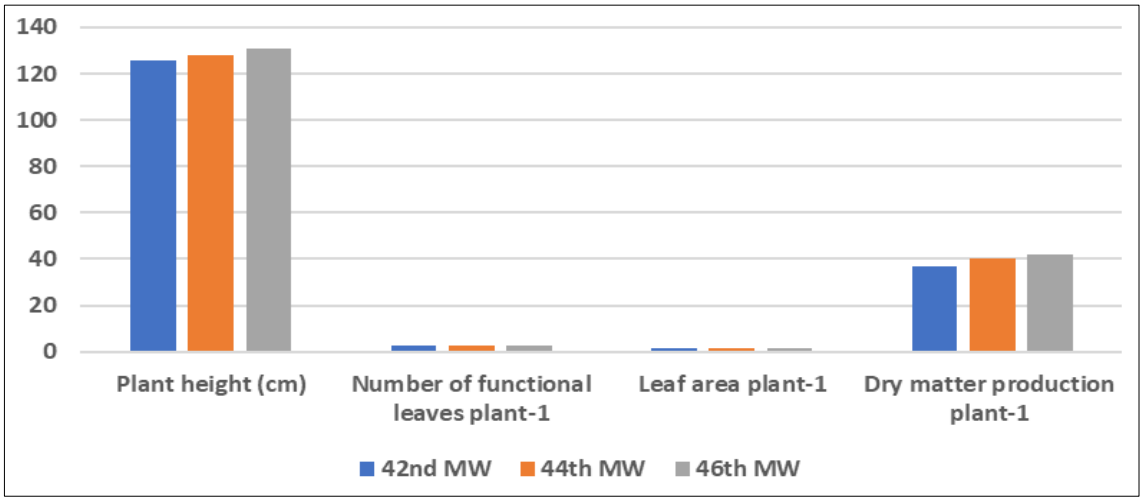

Fig 1: Growth attributes at harvest as influenced by sowing windows

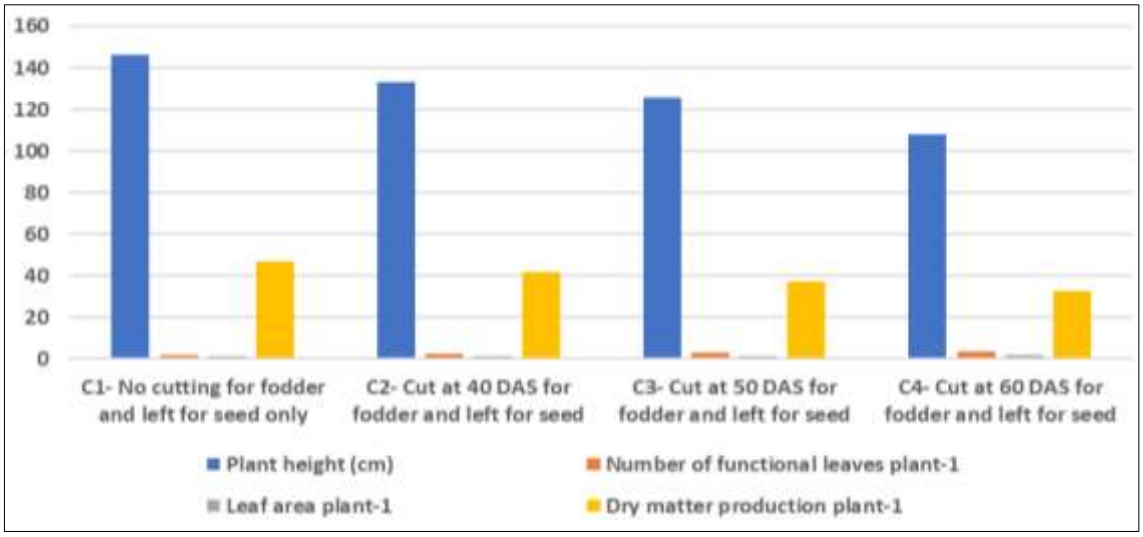

Fig 2: Growth attributes at harvest as influenced by cutting management

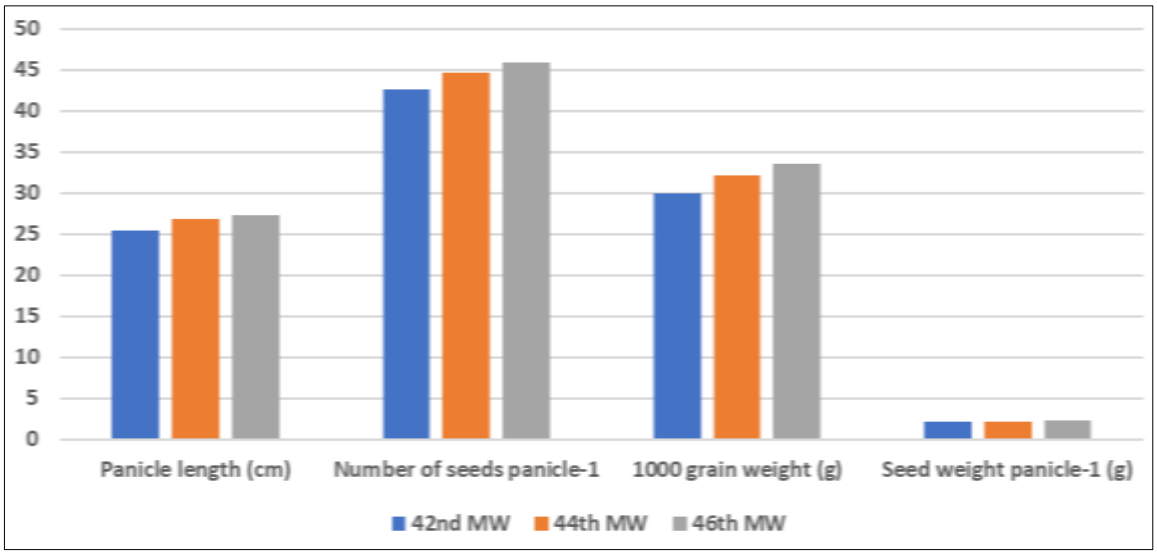

Fig 3: Yield attributes at harvest as influenced by sowing windows

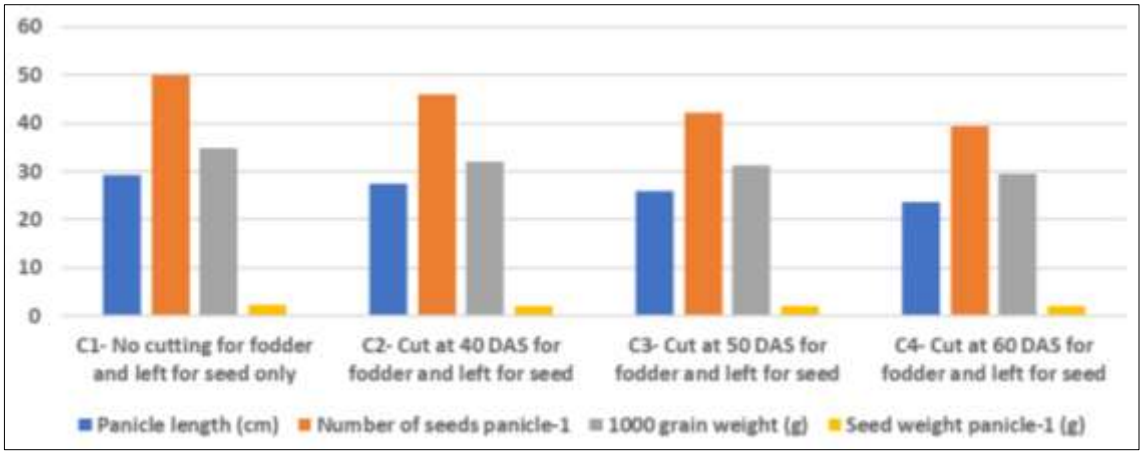

Fig 4: Growth attributes at harvest as influenced by cutting management

Table 3: Yield of oat as influenced by sowing windows and cutting management.

Treatment	Seed yield (t ha^{-1})	Straw yield (t ha^{-1})
A) Main plot (Sowing windows-3)		
S_1-Sowing at 42nd MW (15-21 October)	1.38	12.02
S_2-Sowing at 44th MW (29 Oct-4 Nov.)	1.49	13.81
S_3-Sowing at 46th MW (12-18 Nov.)	1.54	15.25
S.E.m±	0.03	0.50
C.D.at 5%	0.12	1.97
B) Sub plots (Cutting management-4)		
C_1- No cutting for fodder and left for seed only	1.66	15.76
C_2- Cut at 40 DAS for fodder and left for seed	1.54	14.42
C_3- Cut at 50 DAS for fodder and left for seed	1.51	13.36
C_4- Cut at 60 DAS for fodder and left for seed	1.16	11.24
S.E.m±	0.04	0.40
C.D.at 5%	0.13	1.20
C) Interaction (S × C)		
Between two subplots means at same level of main plot mean		
S.E.m±	0.07	0.70
C.D.at 5%	NS	NS
Between two main plots means at same level of sub plot mean		
S.E.m±	0.07	0.79
C.D.at 5%	NS	NS
CV %	8.68	8.85
General mean	1.47	13.69

The seed yield and straw yield of oat were significantly influenced by the different treatments. Amongst the various treatments tested, significantly the highest seed yield (1.54 t ha^{-1}) and straw yield (15.25 t ha^{-1}) was obtained in 46th MW sowing window. This might be due to the fact that all the growth and yield attributes were highest in this treatment (Kumawat *et al*. 2017 and Digamber *et al.* 2020) [5, 3]. With regard to cutting management no cutting for fodder and left for seed only treatment recorded higher seed yield (1.66 t ha^{-1}) and straw yield (15.76 t ha^{-1}). It might be due to the fact that no cut plot received continuous long growth period as compared to 40, 50 and 60 DAS treatments which contributed to higher growth and yield attributing characters (Laxman 2016; Pathan *et al*. 2020) [4, 11].

Conclusion

Results of the study concluded that among sowing windows, sowing on 16th November (46th MW) was found to be significantly higher in terms of growth and yield attributes, grain yield (1.54 t ha^{-1}) and straw yield (15.25 t ha^{-1}). Among cutting management the treatment no cut for fodder and left for seed only produced higher seed and straw yield (1.66 and 15.76 t ha^{-1}, respectively).

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