RESEARCH ARTICLE

EFFECT OF SOWING TIME AND SEED RATE ON THE SEED YIELD OF OATS(*AVENA SATIVA*L.)

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Abstract: A field experiment was conducted during the *rabi* season of 2021-22 at Agricultural Research Farm, School of Agricultural Sciences and Technology, RIMT University, Mandi Gobindgarh, Punjab to study the effect of sowing time and seed rates on grain yield of oats (*Avena sativa* L.). The experiment was laid out in a randomized complete block design (RCBD) and replicated thrice. The treatments comprised of three sowing dates (5th November, 25th November and 15th December) and three seed rate (50,62.5 and 75 kg/ha). The variety OL-14 was used during the experiment. The crop sown on 25th November recorded the highest plant height (149.82 cm), more effective tillers per meter row length (133.70), panicle length (37.90 cm), grains per panicle (81.30), grain weight per panicle (2.90 g) which was significantly higher over 5th November but at par with 15th December sown crop. The highest grain yield was observed in crop sown on 25th November (24.20 q/ha) which was significantly higher over 5th November (21.66 q/ha)sown crop but at par with 15th December (23.02 q/ha) sown crop. The crop sown with seed rate of 75 kg/ha produce more plant height (150.07 cm) which is significantly higher over 50 kg/ha seed rate (142.18 cm)but at par with 62.5 kg/ha (145.39cm) sown crop. Whereas 62.5 kg/ha produce significantly higher grain yield (25.22q/ha) over 50 kg/ha (20.18 q/ha) but at par with 75 kg/ha (23.47q/ha). Interaction effect between sowing dates and seed rateswas found to be non-significant in all the parameters.

Keywords: Oats, Sowing time, Seed rates, Growth parameters, Yield attributes

INTRODUCTION

Oat (*Avena sativa* L.) is one of the important fodder crops widely grown during winter season for green fodder as well as grain purpose in different parts of the world. The genus *Avena* belongs to the grass family Poaceae. It comprises of about seventy species, although mainly *A. sativa*, *A. nuda* and *A. byzantine* are those most commonly cultivated on a commercial scale. This crop is adapted to a wide range of soil types, altitude, rainfall conditions and also tolerate the waterlogged conditions better than most of the other cereals (Mengistu, 1997). It ranks sixth in world cereal production having production of about 22.59 million tonnes, following wheat, maize, rice, barley and sorghum. Russian Federation is the largest oat producer in the world with 4.42 million tonnes production per year and Canada comes second with 4.24 million tonnes yearly production. In India, cultivated fodder is limited to 4.9% of the total cropped area (Kumar *et al.*, 2012). The total area covered under oat cultivation in country is about 1.0 million ha with 35-50 t/ha green fodder productivity and the crop occupies maximum area in Uttar Pradesh (34%), followed by Punjab (20%), Bihar (16%), Haryana (9%) and Madhya Pradesh (6%). In Punjab, during 2019-20 it was grown on 1.06 lakh hectares.

Oat has wider adaptability because of its excellent growing habits, quick regrowth, better yield potential and provides palatable, succulent and nutritious green fodder (Tiwana *et al.*, 2008). Oat is mainly cultivated as fodder for animals and also for grain because of its high nutritional and medicinal value. Food industry fundamentally alter agricultural commodities into foods making it edible, palatable as well as appealing; by innumerable physical and chemical operations increasing shelf-life, bioavailability of the nutrients, stabilizing colour, flavour along with increase in the economic value of the grain. Recent observational and human interventional studies indicate that oats can have an impact on various non-communicable diseases like cardiovascular disease, diabetes; obesity and hypertension etc. The use of its grain is now more focused on its benefits as a health food and the importance of oats in the biochemical and cosmetic industry is also on rise (Tiwari and Cummins, 2009). Oat is now being preferred as a "functional food" as it is rich source of fibres and also has antioxidant properties (Kumari *et al.*, 2013). Oat production is continuously decreased, whereas the demand of oat as a human food has increased because of its dietary benefits of the whole grain and β-glucan content (Buerstmayr *et al.*, 2007).

The yield depends on reaction of different cultivars to environmental conditions such as planting date, cultivars, plant density, types of soil, fertilizer etc. Sowing time depends on weather, topography and harvesting time of the preceding crops. Sowing at an appropriate time is necessary for ensuring maximum yield and that is why it needs to be adjusted so that crop germinates properly and utilize the stored soil moisture effectively. Very early planting may expose the crop to higher temperature at tillering stage while late planting may result in low biomass production and poor grain development due to higher

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temperature conditions at the time of maturity (Ram *et al.*, 2010).

Seed rate determine the planting density which in turn influences the crop growth, nutrient uptake, tillering capacity, number and weight of grains and ultimately grain yield due to inter-plant competition. Generally, the availability of environmental resources to plants is enhanced at optimum seed rate. Seed rate depends on seeding methods The broadcasting method requires more seeds than line sowing. Higher seed rate produces more plants in unit area resulting in less intra-crop competition here by affecting the yield and production cost However, less seed rate results in low plant population which cause greater tiller production, but decrease number of panicles per unit area due to inter tiller competition for plant available resources. Besides, use of high seed rate with narrow row spacing has been observed to enhance grain yield of oats. However, high plant density due to high seed rate never always increase grain yield because of high inter-plant competition and availability of nitrogen and soil moisture.

Even in better adaptability of oats in all parts of the country the spread of this crop is limited because of lack of knowledge on production package apart from limitation of weather. With recent changes in agro-climatic conditions and the unpredictable rainfall pattern of the country, there is a need for oat crop to be tested at different sowing times with different seed rates for the yield optimization. Keeping all these things in view the present investigation has been planned to find out the effect of sowing time and seed rate on the seed yield of oats.

MATERIALS AND METHODS

The experiment was carried out during *rabi* season of 2021-22 at Agriculture Research Farm, RIMT University, Mandi Gobindgarh, Punjab. The experimental field is located at 30.6642°N latitude and 76.2914° E longitude at an altitude of 268 meters above mean sea level. The average annual rainfall of Mandi Gobindgarh is 730.2 mm, about three-fourth of which is contributed by the south-west monsoon during July to September. The experiment was laid out in randomized complete block design replicated thrice. The treatments comprised of three sowing dates (5^{th} November, 25^{th} November and 15^{th}December) and three seed rate (50,62.5 and 75 kg/ha).The variety OL-14 was used during the experiment. The crop was sown with row spacing of 30 cm as per the dates of sowing manually with the help of hand ploughing. The crop was sown with net plot size of 3.0 m × 1.5m. 50 kg N and 20 kg(P_2O_5) per hectare were applied uniformly to all the plots. Half dose of (N) and full dose of(P_2O_5)were added during sowing as basal dose and the remaining dose were added as top dressing after the 30 days of sowing. Five plants were selected randomly from each plot for taking observations. The data on plant height(cm), total number of tillers and effective tillers per meter row length, panicle length(cm), number of grains and grain weight per panicle(g), test weight(g), grains& straw yield(q/ha), biological yield(q/ha) and harvest index (%)were collected and analysed. Harvest index was obtained by dividing the economical (grain) yield from biological yield i.e., straw and grain yield. It was calculated for each plot and was represented in percentage. The formula used to calculate the harvest index was given by Nichiporovich, (1951).The crop was harvested when the panicle turned brown.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The statistical analysis was done by using the statistical software OPSTAT, 1998 (Sheoran *et al.*,1998).

RESULTS AND DISCUSSION

Growth Parameters

Plant height

The Plant height was significantly influenced by different sowing time and seed rate.The maximum plant height was observed on 25^{th} November (149.82 cm) sown crop which was significantly higher over 15^{th}December (141.48 cm) but at par with 5^{th} November (146.18 cm) sown crop (Table no:- 1). The increase in plant height in normal sown crop i.e., 25^{th}November might be due to the favourable prevailing conditions. Similar results was reported by Bahadur *et al.*, (2019), Ali*et al.,* (2016) and Shivhare *et al.* (2020). The crop sown with seed rate of 75kg/ha produce significantly higher plant height i.e (150.07 cm) over 50kg/ha seed rate (142.18 cm) but at par at 62.5 kg /ha seed rate (145.39 cm). The main reason for having higher plant height from high seeding rate may be due to plant competition for light. Similar observation was recorded by Iqbal *et al.,* (2012. The interaction between sowing time and seed rate for plant height was found to be non-significant.

Total number of tillers per meter row length:TheCrop sown on 25^{th}November produce significantly more tillers (187.00) over 5^{th} November (168.20) and 15^{th} December (179.40) sown crop (Table no:- 1).Very early planting may expose the crop to higher temperature at tillering stage and late planting may expose the crop to low temperature.The increase in tillers per meter row length might be due to tillering in normal sown gives the crop the necessary number of stalks required for a good production. Bahadur *et al.*,(2019) reported the similar result. The crop sown with seed rate of 50 kg /ha produce significantly more tillers (185) over 62.5 kg/ha (179.40) and 75 kg/ha (170.20) sown rate.Similar observation wasrecorded by Soomro *et al.,* (2009). The reason behind the production of

maximum tillers in less seed rate is more spacing between the plants and less competition between the plants.The interaction between sowing time and seed rates was found to be non –significant.

Effective tillers per meter row length:The Crop sown on 25thNovember produce significantly more effective tillers (133.70) over 5th November of sowing (126.20) but at par with sowing done on 15th December (130.80)(Table no:- 1). Less number of effective tiller under15th December might be due to its shorter growing period, due to which the late tiller could not turn out to be effective. The increase in effective tillers per meter row length may be due to maximum number of total tillers and the crop get the favourable environmental conditions.Similar observation was recorded by Bahadur *et al.*,(2019). The crop sown with seed rate of 50 kg /ha produce significantly more effective tillers (138.00) over 75 kg/ha seed rate (128.40) but at par with crop sown with seed rate of 62.5 kg/ha (134.60). Similar observation was recorded by Soomro *et al.*, (2009).The reason behind the production of maximum tillers in less seed rate may be due to more spacing between the plants and less competition between the plants.The interaction between sowing time and seed rates was found to be non –significant.

Yield attributes

Panicle length: The date of sowing had significant effect on panicle length. Crop sown on 25th November produce significantly higher panicle length (37.90 cm) over 5th November sowing (33.00 cm) and at par with 15th December sowing (36.00 cm)(Table no:- 1).The increase in panicle length in normal sown crop i.e., 25th November might be due to favourable prevailing condition and better development of plant than late and early sown crop.This could be due to the availabilityof more nutrients for proper development of vegetative parts of plant including panicle under higher doses of seed rate kg/ha. These result are in agreement with those observed by Iqbal *et al.*,(2012). The interaction between sowing time and seed rates was found to be non –significant.

Number of grains / panicle: The highest grains per panicle were recorded on 25th November sown crop (81.30) which was significantly higher over 5th November (72.80) but was at par with 15th December (80.00) sown crop (Table no:- 2). The increase in normal sown crop i.e., 25thNovember might be due to suitable temperature and translocation of more photosynthesis resulting ina greater number of grains per panicle than late sown crop. Similar observations were recorded by Mumtaz *et al.,* (2015). The seed rate of 50kg/ha significantly produce higher number of grains (83.80) over other two seed rates i.e 62.5 kg/ha (77.20), 75 kg/ha (73.10). Since grain filling is depended on nutrient supply and environmental condition, increasing plant density resulted in increased competition for nutrients and sunlight. At later most grains would fade at early stages, because of competition between growing grains to absorbing reserved matters and as result low grains would be produced. Due to more spacing and less competition between plants the less seed rate i.e 50kg/ha produce more number of grains. Similar observations were recorded by Soomro *et al.,* (2009). Bekele *et al.,* (2020) reported that increasing seeding rate from 100 -175kg/ha, the number of kernel per spike was decreased by 28.2%. The interaction between sowing time and seed rates was found to be non –significant.

Grain weight per panicle: The crop sown on 25th November significantly produce higher grain weight per panicle (2.90 g)over crop sown on 5th November (2.30g) but was at par with crop sown on 15th December (2.63 g) (Table no:- 2). The increase in grain weight per panicle might be due to longer reproductive phase in the normal sowing crop. The seed rate of 50 kg /ha produce significantly highest grain weight (3.10 g) over the seed rate of 62.5 kg/ha (2.60g) and 75 kg/ha (2.30 g). Due to more spacing and less competition between plants the less seed rate i.e 50kg/ha producedhighest grain weight. Similar observations were recorded by Soomro *et al.,* (2009). The interaction between sowing time and seed rates was found to be non –significant.

1000 grain weight: The crop sownon 25thNovember **produce** significantly higher test weight (36.90 g) over other sowing dates i.e 5th November (31.20 g) and 15th December (32.40g)(Table no:- 2). The increase in test weight in normal sown crop i.e., 25th November might be due to better yield contributing characters viz. number of grains per panicle and grain weight per panicle. Similar observations were recorded by Mumtaz *et al.,* (2015). The crop sown with seed rate of 50kg/ha produced significantly more test weight (37.30 g) over crop sown with seed rate of 75 kg/ha (31.80 g) but at par with crop sown with 62.5 kg/ha (33.70g). Due to high population density number of panicle increased which result in increased competition. So the little photosynthesis would be available for grain filling and finally thousand grain weight would reduce due to increasing number of panicle. Therefore, insufficient photosynthesis during grain filling stage in thick density may be the possible reason to decrease thousand kernel weights.Bekele *et al.,* (2020) observed that when seeding rate increased from 100–175 kg ha^{-1} resulted in decreased thousand kernels weight by 23.51%. The interaction between sowing time and seed rates was found to be non –significant.

Grain yield: The crop sown on 25th November produced significantly higher grain yield (24.20 q/ha) over crop sown on 5th November (21.66 q/ha) but at par with crop sown on 15th December (23.02q/ha)(Table no:- 3). The increase in grain yield with normal sown crop i.e., 25th November might be due to reason that environmental conditions remained quite favourable for its growth at all growth stages.Similar observation was recorded by

Mumtaz *et al.,* (2015). The crop sown with seed rate of 62.5 kg/ha produced significantly higher grain yield (25.22 q/ha) over seed rates 50kg/ha (20.18 q/ha) but at par with 75kg/ha (23.47q/ha).Similar observation was recorded by Bezabih Woldekiros (2020). Increasing the seeding rate led to increase the number of plants per unit area, consequently increasing the number of tiller and this in turn caused an increase in the number of panicle thus increase grain yield. The interaction between sowing time and seed rates was found to be non –significant.

Biological yield: Thecrop sown on 25th November produce significantly higher biological yield (136.77 q/ha) over 5th November (127.77 q/ha) and 15th December (130.24 q/ha) sown crop (Table no:- 3). The crop sown with 62.5 kg/ha seed produce significantly higher biological yield (136.11 q/ha) over 50kg/ha (127.13q/ha) but at par with 75 kg/ha (131.55 q/ha). Hajighasemi *et al.,* (2016) showed biological yield increased with increasing seed rate from 400-800 seeds m^{-2}. The interaction between sowing time and seed rates was found to be non – significant.

Straw yield: Thecrop sown on 25th November produce significantly higher straw yield (112.57 q/ha) over 5th November (106.11 q/ha) and 15thDecember (107.22 q/ha) sown crop (Table no:- 3). The crop sown with 62.5 kg/ha seed produce significantly higher straw yield (110.89 q/ha) over 50kg/ha (106.95 q/ha) but at par with 75 kg/ha (108.89 q/ha). El-Lattief (2014) also concluded that maximum straw yields were observe in 300 seeds m^{-2} (6.582 t ha^{-1} in 2010-11 and 6.654 t ha^{-1} in 2011-12) over the 100, 200,400 seeds m^{-2}. The interaction between sowing time and seed rates was found to be non –significant.

Harvest index: The more harvest index (17.69) was observed in crop sown on 25th Novemberthan other sowing i.e 5th November (16.95) and 15th December (17.67) **(**Table no:- 3).Themaximum harvestindex ismight be due to higher grain yield observed on 25th November of sowing.The more harvest index (18.52) was observed in crop sown with seed rate of 62.5kg/ha than other seed rates 50kg/ha (15.87) and 75 kg/ha (17.84).

Table 1. Effect of sowing time and seed rate on plant height (cm), total number of tillers per meter row length, effective tillers per meter row length and panicle length (cm) of oats (variety OL-14).

Treatments	Plant height (cm)	Total no. of tillers/m row length	Effective tillers /m row length	Panicle length (cm)
5th November	146.18	168.20	126.20	33.00
25th November	149.82	187.00	133.70	37.90
15th December	141.48	179.40	130.80	36.00
CD at 5%	7.793	3.93	3.6	2.49
SEm±	2.57	1.30	1.21	0.82
50	142.18	185.00	138.00	37.70
62.5	145.39	179.40	134.60	36.00
75	150.07	170.20	128.40	33.20
CD at 5%	7.79	3.93	3.65	2.49
SEm±	2.57	1.30	1.21	0.82
Interaction	N/S	N/S	N/S	N/S
SEm±	4.46	2.253	2.09	1.43

Table 2. Effect of date of sowing and seed rate on Number of grains per panicle, Grain weight per panicle (g) and 1000 grain weight (g) of oats (variety OL-14).

Treatments	Number of grains per panicle	Grain weight per panicle (g)	1000 grain weight (g)
5th November	72.80	2.30	31.20
25th November	81.30	2.90	36.90
15th December	80.00	2.63	32.40
CD at 5%	5.92	0.31	3.71
SEm±	1.95	0.10	1.22

Seed rate kg/ha			
50	83.80	3.10	37.30
62.5	77.20	2.60	33.70
75	73.10	2.30	31.80
CD at 5%	5.92	0.31	3.71
SEm±	1.95	0.10	1.22
Interaction	N/S	N/S	N/S
SEm±	3.39	0.17	2.12

Table 3. Effect of date of sowing and seed rate on grain yield (q/ ha), biological yield, straw yield (q/ ha) and harvest index (%) of oats (variety OL-14).

Treatments	**Grain yield (q/ha)**	**Straw yield (q/ha)**	**Biological yield (q/ha)**	**Harvest index (%)**
5th November	21.66	106.11	127.77	16.95
25th November	24.20	112.57	136.77	17.69
15th December	23.02	107.22	130.24	17.67
CD at 5%	1.80	3.89	6.07	-
SEm±	0.59	1.32	2.00	-
Seed rate kg/ha				
50	20.18	106.95	127.13	15.87
62.5	25.22	110.89	136.11	18.52
75	23.47	108.89	131.55	17.84
CD at 5%	1.80	3.89	6.07	-
SEm±	0.59	1.32	2.00	-
Interaction	N/S	N/S	N/S	-
SEm±	1.03	0.70	3.47	-

CONCLUSION

On the basis of the present study, it may be concluded thatthe crop sown on 25th November produced more grain yield (24.20 q/ha) than other date of sowings. Similarly, the crop sown with seed rate of 62.5 kg/ha produced maximum grain yield(25.22 q/ha) than other sowing rates. So, the crop sown on 25th November with the seed rate of 62.5 kg/ha may bepreferred.

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