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# COMPARATIVE ANALYSIS OF GROWTH AND SEED YIELD AMONG DIFFERENT OAT VARIETIES

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**ABSTRACT**

Oat (*Avena sativa* L.) is a cereal crop of global importance used for food, feed, and forage. Deficit of the feed and fodder availability of the desired quality has been considered as the major bottleneck in harnessing the potential of the livestock sector in India. With the objective to find out the suitable variety of oat for getting maximum seed yield, a field experiment was conducted during *rabi* season of 2017 to 2022 at different locations of district Reasi, Jammu and Kashmir under KVK, Reasi (Jammu and Kashmir). The treatments consisted of six varieties of oat (Sabjar (SKO-7), SKO-90, SKO-96, Kent, Weston II, HJ-8). The results showed that the variety SKO-7 produced the highest number of tillers/m2, panicle weight and 1000 grain weight which resulted into higher seed yield (3.64 t/ha) than other varieties followed by Kent (3.52 t/ha) whereas, the variety HJ-8 recorded lowest (2.86 t/ha) but its variation with SKO-90 (2.95 t/ha), SKO-96 (3.10 t/ha) and Weston II (3.18 t/ha) was not significant. The straw yield was higher under variety SKO-7 (10.62 t/ha) compared to other varieties. Growth parameters such as crop growth rate, relative growth rate and leaf area index were superior for variety SKO-7 and Kent recorded highest benefit-cost ratio (2.84), which was due to high gross as well as net monetary returns obtained.

***Key words :*** *Avena sativa* L., benefit-cost ratio, forage dry matter, oat varieties, net monetary returns, yield.

## Introduction

With a sizable rural population, Jammu and Kashmir, a state in the northwest Himalayas, is predominantly an agrarian region. In the state, raising cattle is the secondary industry in low-lying plains areas, while agriculture dominates in higher altitudes, with the opposite pattern seen elsewhere. According to Anonymous (2009), there are 7.8 million cattle in the state, and the amount of fodder produced is insufficient to fulfill the needs of this growing population. About 64 lakh MT of green fodder and 35 lakh MT of dry fodder are produced in the state. On the other hand, 58.53 lakh MT of dry feed and 139.13 lakh MT of green feed are needed. Thus, bridging the gap between fodder supply and need is a big problem (Ahmad *et al.*,2016). Farmers have a shortage of fodder, especially during the long, lean winter months when their main source of fodder is the dried stalks of summer cereals or summer grasses and legumes. Therefore, fodder cultivation is crucial to make up for fodder shortages during a lean season (Ahmad *et al.*, 2015). According to Singh and Chauhan (2017), Oat (*Avena sativa* L.) is a cereal crop of global importance used for food, feed, and forage (Tinker *et al.*, 2009). Differing from other cereal grains such as wheat (*Triticum aestivum* L.) and barley

(*Hordeum vulgare* L.), oat is a multipurpose cereal crop grown worldwide for human food and animal feed (Dubey *et al.,* 2014). Quality Oats are increasingly in demand and in many places a highly-profitable market grain. Livestock production is the backbone of Indian agriculture contributing 7% to national GDP and source of employment and ultimate livelihood for 70% population in rural areas. India is having the largest livestock population of 520 million heads, which is about 15% of the world's livestock population (Neelar, 2011). The animal products make a larger contribution to dietary energy in the developed countries than developing ones. There is tremendous pressure of livestock on the available total feed and fodder, as land available for fodder production has been decreasing. At present, the country faces a net deficit of 63% green fodder, 24% dry crop residues and 64% feeds (Kumar *et al.,* 2012). The scenario of food security for a huge cattle population of the country is quite different. The crop residues mainly constitute the major feed material for the animals. The national effort towards ensuring adequate availability of livestock products like milk, meat and wool is hampered, to a greater extent by the shortage of nutritive forage from grasslands and fodder crops. The productivity of our livestock often remains low due to inadequate and nutritionally unbalanced supply of feed and fodder. Half of the total losses in livestock productivity are contributed to by the inadequacy in supply of feed and fodder (DARE, 2013). Thus emerging shortage of adequate and qualitative fodders and feeds to livestock is posing severe threats in maintaining the sustainable productivity of milk and other livestock products. The success of livestock industry depends upon availability of the quality fodder to meet out their nutritional requirement for maintenance and production. Recently, there has been a rapid change in the way agricultural scenario is shifting. There is need to meet the demand of increasing number of livestock and also enhance their productivity for which availability of feed resources have to be increased.

Oat 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. It ranks sixth in world cereal production following wheat, maize, rice, barley and sorghum. It was produced in 10212 million ha area with an annual production of 233 million tons in the world (Anonymous, 2009). In India, cultivated fodder is limited to 4.9% of the total cropped area (Kumar *et al.,* 2012). The total area under cultivated fodders is 8.6 million ha on individual crop basis. Sorghum amongst the *kharif* crops (2.6 million ha) and berseem (Egyptian clover) amongst the rabi crops (1.9 million ha) occupy about 54% of the total cultivated fodder cropped area. The total area covered under oat cultivation in the country is about 1.0 million ha with 35-50 t/ha green fodder productivity (IGFRI, 2011). Oats (*Avena sativa* L.) are a significant cereal feed crop and a rich source of minerals, phosphorus, iron, protein, vitamin B1, energy, and other nutrients (Kumawat *et al.,* 2017). After wheat, maize, rice, barley, and sorghum, it comes in sixth place in the world's cereal output (Ratan *et al.,* 2016). It is an annual crop that may be planted in the spring for an early autumn harvest or in the fall for a late summer yield. In Jammu and Kashmir State, oats are a significant crop for Rabi fodder, yet current output does not keep up with demand (Ahmad *et al.,* 2014). Oats are produced for its grain properties as well as for use as bedding straw, hay, haylage, silage, and chaff in many regions of the world (Abhishek *et al.,* 2014). It is necessary to create varieties with greater forage production potential and quality in order to raise productivity per unit area (Dar *et al.,* 2014). The distinct development habits and phenology of several oat cultivars influence their yield and related characteristics (Palsaniya *et al.,* 2015; Shah *et al.,* 2015). In order to close the gap between the supply and demand of green fodder, forage oat types with improved quality, increased production, and resistance to abiotic stress are desperately needed (Ahmad *et al.,* 2015).

In India, it is grown in Punjab, Haryana, Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra and West Bengal. The crop occupies maximum area in Uttar Pradesh (34%), followed by Punjab (20%), Bihar (16%), Haryana (9%) and Madhya Pradesh (6%) (Agricultural Statistics, 2006-2007). In Madhya Pradesh, it is cultivated in about 790 ha area under irrigated and rainfed conditions (Argil. Statistics, 2006 to 2007). It constitutes 30% of the Indian market in terms of volume for breakfast foods next only to Cornflakes and 18% in value terms (Government of Western Australia, 2012). High grain yield is the most desired characteristic of oat cultivars. Most of the fodder crops are grown under irrigated situations except in areas, which receive adequate winter rains. Under such situations where water supply is limited and the farmers are not in a position to grow the crops having high water requirement such as lucerne and berseem, oat can grow successfully, which provides energy rich nutritious and palatable fodder for livestock. The livestock grain feed is still the primary use of oat crops, accounting for an average of around 74% of the world's total usage (Welch, 1995). It can be fed in any form like green forage or silage to the animals covering the scarcity period of the year.

The availability of good quality seed of forage crops in sufficient quantity is one of the major constraints, though improved varieties of various fodder crops have been evolved and the agro-techniques have also been developed to obtain their high yield potential. Secondly, the forage crops are usually harvested for fodder purpose before the seed setting. Thus, the opportunity for seed production is limited. The attraction of farmers for seed production of forage crops, particularly oat can be made possible by introducing the varieties, which are having the potential of producing higher seed yield. Increased nutritional demand for optimal animal performance has challenged oat producers to select superior oat variety, and to combine good management practices to produce crops with high yield and favorable quality characteristics (Kim *et al.*, 2006). Oat continues to be an important fodder crop because of their high yield potential and very good feed quality. Recently some new varieties of oat have been developed, which are having capacity to produce higher seed yield. The performance of these varieties is to be compared for their seed production with the existing improved varieties. Therefore, keeping all the above facts in view, the present investigation was undertaken with the objective to identify oat varieties with superior seed yield for livestock production.

## Materials and Methods

A field experiments were conducted during rabi (winter) season of 2017 to 2020 at the Farm Science Centre and in the district Reasi of Jammu and Kashmir, India under on Farm (OFTs) programme on fodder oats and at different cluster villages, Dadura (N320 59.172 E 74-58.289 with elevation of 3061m), ArliHansali (N320 58-90 E 74-56.41 with elevation of 2699m), Maghal (N320 57.97E 74-55.79 with elevation of 2460m), ChakBhagta (N320 57.78 E 74-57.45 with elevation of 2465m), KotliBajalian (N320 58.902 E 74-54.69 with elevation of 2591m), SlalKhad (N330 09.410 E 74-48.869 with elevation of 2540m) and Gran Morh (N330 05.167 E 74-52.38 with elevation of 2237m) during the year 2017 to 2020 in 28 villages. In general, soils of the area under study were sandy loam to clay loam in texture with average pH 7.7, organic carbon 0.58 to 0.65, high in nitrogen, phosphorus and potash. Cluster selections, farmer selection, problem diagnosis, layout of demonstration were carried out according to Choudhary (2015). The climate of the region is sub-tropical with hot dry summer and cool dry winter. The location falls under the maize-wheat cropping system zone of Jammu, which lies in the "Shivalik Foot hills" agro-climatic zone of India. The average annual rainfall is nearly 1358 mm, which mainly received between mid June to September with maximum concentration in the month of July and August. There are nominal rain (less than 70 mm) occasionally received during the remaining months of the year. The mean relative humidity (RH) varies from 15% in summer to 90% during rainy season. In the region, the temperature rises as high as up to 44.3°C during May to June months, while the minimum temperature goes down up to 1°C during the winter followed by occasional frost.

The soil was sandy clay loam in texture, neutral in reaction (pH 7.2) with low organic carbon (0.44 g/kg) and available nitrogen (228 kg/ha) and medium in available phosphorus (16.2 kg/ha) and potassium (297 kg/ha). The electrical conductivity of the soil (0.34 d/Sm) was normal. The experiment consisted of six treatments of oat varieties namely Kent, Sabzar (SKO 7), SKO-90 (Shalimar fodder oats – 2), Weston II, SKO-96, Haryana Javi-8 (HJ -8) were laid out in randomized block design with four replications on well prepared and levelled field. All the treatments were randomly allocated to different plots in each replication with a plot size of 4.0 x 3.0 m. A uniform dose of 40 kg $P_2O_5$/ha and 20 kg $K_2O$/ha was applied as basal to all plots through single super phosphate and Muriate of potash, respectively. Nitrogen was applied through urea in two split doses as 40 kg at basal and remaining 40 kg at tillering stage. The basal dose of fertilizers was applied in furrows nearly 2 cm below the seeds. Before sowing, the seeds were treated with thirum at 3 g/kg of seeds. Sowing was done uniformly in all the plots manually by using 100 kg seeds/ha with a row spacing of 25 cm. All the standard agronomic management practices were adopted. Growth parameters, yield attributes and yield of different varieties were recorded as per the standard procedure at crop maturity. Standard procedures were used for chemical analysis of soil. The economic parameters (gross returns, net returns and B : C ratio) of the treatments were worked out on the basis of prevailing market prices of inputs and outputs. The data were analyzed using the 'Analysis of Variance Technique' as per the standard procedure. The treatment means were compared at 5% level of significance.

### Agronomic characteristics of varieties

### Kent

This variety is introduced from Australia; plants are semi dwarf (100 to 125 cm) and bear maximum tillers/ $m^2$ (135 to 140). The length of panicle (25 to 30 cm), weight of panicle (3.20 to 3.30 g), seeds/panicle (90 to 100) and test weight (37.40 to 37.60 g). It is widely adopted for fodder and seed production.

**Sabzaar**

The variety was released in 1997 and developed by SKUAST, Srinagar. The variety has been notified for cultivation in temperate areas of kashmir and high altitude regions of jammu. The variety is profuse tillering, leafy and suitable for dual purpose. It produces 35–40 t/ha of green fodder.

**Weston II**

This is an exotic introduction and has been released in 1978 and notified for cultivation in punjab. The variety is semi erect with a height of 155 cm. The leaves are broad with smooth panicles. The day to flowering is 110 days and maturity is 160 days. The glumes are yellowish and grains are long and amber in colour. The green fodder yield is 50 t/ha.

**SKO-90 (Shalimar fodder oats – 2)**

This variety has been developed from IGFRI, Jhansi, India through a cross between IGO-4262 X Indio 6-5-1. It is widely grown in the central part of India. Plants are with medium height (120 to 130 cm) and a good number of tillers/m2 (130 to 140). The length of panicle, weight of panicle, seeds/panicle and test weight of variety is 25 to 30 cm, 3.30 to 3.50 g, 95 to 105 and 35.75 to 35.95 g respectively.

**Haryana Javi-8 (HJ-8)**

The variety was developed by CCS HAU Haryana from os- 7 × s-3021 p15 and released in 1997 for Haryana. It has fast growth, better regeneration and suitable for two cuts. The flag leaf of the variety remains erect at the time of panicle emergence and panicle is straight and open. The variety provides 65 t/ha green fodder and is suitable for two cuts.

## Results and Discussion

**Effect on growth parameters**

Three newly developed oat varieties SKO-7, SKO-96, SK-90 and three recommended high yielding variety Kent, Weston II, Haryana Javi-8 were compared for their growth performance under this study. The growth parameters *viz.* plant height, tillers/$m^2$, leaf area index (LAI), crop growth rate (CGR) and relative growth rate (RGR) gradually increased under all varieties with the advancement in growing periods till harvest of the crop. The increase in plant height continued till the final stage because of phase changes in plants from vegetative to reproductive phase. The results showed that the variety SKO-7 (SABZAR) had significantly taller plants (135.2 cm) than others, followed by SKO-90 (126.4 cm), SKO-96 (125.45 cm), Kent (124.35 cm) and Weston-II (122.45 cm) which had almost similar plant height (Table 1). Differences in plant height among varieties are expected due to genetic make-up of the varieties. The significant effect of variety on plant height in present study is in agreement with previous findings (Kibite *et al.,* 2015b; Chohan *et al.,* 2018; Hussain *et al.,* 2005). It is apparent from the data that the number of tillers/m2 increased with the advancement in growth period of crop under all varieties. Variety SKO-7 produced maximum number of tillers/m2 and proved significantly superior over Kent, SKO-90, SKO-96, and HJ-8, but it was non-significant to Kent and Weston II at all the growth stages. Similarly, the LAI showed rapid rate of increment during the growth period under all varieties but it did not indicate marked variations among varieties at any of the growth stages. Variety Kent recorded highest LAI (2.92) at 90 DAS but the differences were not significant among the varieties and SKO-7 was the lowest (2.07) in this regard. It is clear from the data that CGR as well as RGR were greatly influenced due to varieties. Data revealed that CGR as well as RGR increased upto 90 DAS under all varieties, but after that it was declined. RGR was highest at 60 DAS for all the varieties and later on declined slowly. Variety Sabzar SKO-7 recorded higher values of CGR which was non-significant to SKO-96 and Kent, than SKO-90 and JH-8 at 90 DAS recorded minimum CGR value**.** Whereas, in case of RGR Kent recorded maximum value which was non-comparable to SKO-7, JH-8 and Kent. Variety SKO-7 followed by Weston II produced considerably higher dry matter at harvest among all the other varieties (Table 1). Dry matter production of HJ-8 variety was minimum (9.74 t/ha) at harvest but it was comparable to Kent, SKO-90 and SKO-96 (9.97, 10.13 and 10.23 t/ha). These parameters are generally expression of the varieties. The variation in various growth parameters among the varieties may be due to their genetic constitution during crop growth period. Similar patterns of growth in oat have been also reported by Kumar *et al.,* (1992); Lupingan *et al.,* (2015) and Naeem *et al.,* (2015).

**Effect on yield attributes and yield**

The yield attributing characters such as panicle length, panicle weight, grains per panicle and 1000-grain weight was found to be influenced by the various varieties. Higher values of LAI under SKO-7 and Kent for all the parameters due to enhanced efficiency and effectiveness in interception, absorption, utilization of the energy radiated by the sun, which ultimately led to higher photosynthesis rate and ultimately led to more accumulation of dry matter by the plant to enhance the accumulation of dry matter by the plant and which helped in realizing higher seed yield; 3. 2 and 3.64 t/ha respectively of these varieties.

**Table 1 :** Influence of different oat varieties on growth parameters, yield attributes and yield at harvest.

| Treatment | Plant height (cm) | Tillers /m² | Dry matter production (t/ha) | Panicle length (cm) | Panicle weight (g) | Grains per panicle (No) | 1000-grain weight (g) | Seed yield (t/ha) | Straw yield (t/ha) | HI* (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| SKO -7 | 135.2 | 143.2 | 11.48 | 29.6 | 4.12 | 109.0 | 35.0 | 3.64 | 10.62 | 27.3 |
| SKO -90 | 126.4 | 130.2 | 10.13 | 27.5 | 3.57 | 103.2 | 34.4 | 2.95 | 9.55 | 22.6 |
| SKO-96 | 125.4 | 128.1 | 10.23 | 26.9 | 3.34 | 96.0 | 32.9 | 3.10 | 8.22 | 21.2 |
| Kent | 124.3 | 138.2 | 9.97 | 28.3 | 3.88 | 92.0 | 37.5 | 3.52 | 10.18 | 26.9 |
| WestonII | 122.4 | 136.2 | 10.91 | 28.3 | 3.42 | 100.8 | 35.8 | 3.18 | 9.32 | 25.4 |
| HJ-8 | 111.0 | 130.1 | 9.74 | 27.1 | 3.33 | 88.2 | 41.5 | 2.86 | 8.10 | 31.0 |
| CD@0.5% | 5.45 | 7.10 | 1.12 | 1.35 | 0.45 | 6.00 | 0.55 | 0.45 | 0.90 | NS |

**HI*:** Harvest Index.

**Table 2 :** Influence of different oat varieties on economic return.

| Treatment | Cost of cultivation (Rs./ha) | GMR (Rs./ha) | NMR (Rs./ha) | B:C ratio |
|---|---|---|---|---|
| SKO -7 | 14920.52 | 57435 | 42514.48 | 2.84 |
| SKO -90 | 14920.52 | 49410 | 34489.48 | 2.31 |
| SKO-96 | 14920.52 | 47816 | 32895.48 | 2.20 |
| Kent | 14920.52 | 56143 | 41222.48 | 2.76 |
| Weston II | 14920.52 | 46619 | 31698.48 | 2.12 |
| HJ-8 | 14920.52 | 50962 | 36041.48 | 2.41 |

**GMR**-Gross monetary returns, **NMR**-Net monetary returns, **B:C**-Benefit-cost ratio (Selling price of grains- Rs. 1500/q, Straw- Rs. 35/q)

Nonetheless, it was observed that variety SKO-7 performed significantly better in terms of panicle length and number of grains per panicle and weight of panicle (29.65 cm in and 109.03), while variety Kent possesses the second-best figure and test weight (3.88 and 41.50 g) (Table 1). This was due to the genetic character of different yield attributing characters with their corresponding variability. These findings are quite in sync with the study done by Lupingan *et al.* (2015); Naeem *et al*. (2015), Singh and Singh (1992). The overall increase in the rate of crop growth positively affected the source-sink relationship, which paved way for better yield features.

Based on the results, variety SKO -7 produced higher seed yield (3.64 t/ha) followed by Kent (3.52 t/ha) compared to other varieties but do not differ significantly. Variety HJ-8 and Weston II being at par to SKO-90 and SKO-96 was noted to be lower among all in seed yield. The improved yield attributing characters *viz*. more number of tillers/m², higher panicle weight and 1000 grain weight under variety SKO -7 might have attributed to higher seed yield under this variety. The seed yield of crop had strong possible correlation with number of tillers/ m2, weight of panicle and test weight as reported by Kibite (1997); Lacko-Bortosova *et al.*, (2015) and Villasenor-mir *et al.*, (2018).

The straw yield was differed non-significantly among the varieties. It was remarkably higher under variety SKO -7 (10.62 t/ha) followed by Kent (10.18 t/ha) next to it, which marked superiority over others. This might be due to its higher dry matter production and lower seed yield, which increased the proportion of straw in the total biomass obtained under this variety. Variety SKO-96 non-comparable to HJ-8 had a considerably lower straw yield as compared to others. The variations in straw yield under different varieties may be due to the differences in plant height and number of tillers/m2 recorded with them. The straw yield had a strong positive relationship with plant height and number of tillers/m2. These results are corroborated with the findings of Singh and Nanda (1998) and Nazakat *et al.*, (2018).

While the highest harvest index was significantly differed among the varieties and it was maximum (31%) in HJ-8 where as SKO-96 had the lowest harvest index (21.2%) as compared to other varieties (Table 1). 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 and assimilate distribution (Dreccer *et al.*, 2009).

## Economics

The cost of cultivation was same under all the treatments. It did not vary because all the operations and

inputs used in raising the crop were similar under each treatment. The expenditure incurred for each variety was 14920.52/ha. The gross monetary return (GMR) is the value of the produce under different treatments. Since the quantity of economic produce (seed and straw yield) was varied due to the different varieties, hence GMR also differed with these treatments. Among the varieties, SKO-7 (Sabzaar) fetched maximum GMR followed by Kent but not much difference between them (Table 2). All other varieties led to record the lesser GMR because of low seed and straw yield production. Thus, variety SKO-7 fetched highest net returns and B:C ratio ( 42514.48/ha and 2.84) which was closely followed by Kent ( 41222.48/ha and 2.76). But other varieties resulted into lesser net returns and B:C ratio.

## Conclusion

Based on the findings of the present investigation, it may be concluded that the SKO -7 proved superior variety with respect to various growth parameters viz. number of tillers/m2, LAI, CGR and RGR as well as yield attributes such as weight of panicle and test weight. It proved to be most suitable and remunerative variety for getting higher seed yield and led to record the highest gross as well as net monetary returns and benefit-cost ratio.

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