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Effect of cutting management on productivity, profitability and quality of dual purpose oat (*Avena sativa*) cultivars in Shiwalik foothill plains

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ABSTRACT

A field experiment was conducted during winter (*rabi*) seasons of 2018–19 and 2019–20 at research farm of Sher-e-Kashmir University of Agricultural Sciences and Technology Jammu, Jammu and Kashmir to assess the effect of cutting management on productivity and profitability of dual purpose oat (*Avena sativa* L.) cultivars. Experimental results revealed that the yield attributes and productivity of dual purpose oat cultivars were significantly influenced by cutting management. Dual purpose oat cultivar treatments with single cut recorded significantly higher number of tillers/m^2, number of grains/panicle, 1000-grain weight, grain yield, straw yield and harvest index as compared to treatments with double cut which recorded significantly higher forage yield, grain equivalent yield, net returns and B:C ratio. Among the oat cultivars evaluated in the experiment, JHO-2000-4 consistently outperformed the other cultivars in both cutting managements. In the single cut management system, JHO-2000-4 achieved significantly highest grain equivalent yield compared to all other single cut treatments. Similarly, in the double cut management system as well, JHO-2000-4 exhibited significantly higher forage yield, grain equivalent yield, gross returns, net returns, and B:C ratio. These results contribute to our understanding of the potential benefits of specific cutting management strategies and cultivar selection for optimizing oat productivity and profitability. Based on the findings of this study, it can be concluded that the cultivation of oat cultivar JHO-2000-4 using double cut approach involving cuts 60 DAS and 105 DAS can provide superior forage yield, grain equivalent yield, and higher economic returns.

Keywords: Cutting management, Economics, Forage yield, Grain equivalent yield, Oat cultivars

The fodder sector, a crucial aspect of India's agricultural framework, has long been neglected, resulting in a significant shortage of both green and dry forage resources. Statistics show deficits of 11.24% in green fodder and a substantial 23.4% in dry fodder (Roy *et al*. 2019). This shortage arises from limited land resources, suboptimal farming practices, and erratic climate patterns, posing challenges to the availability of nutritious fodder. India grapples with the double burden of increasing livestock numbers and constrained fodder resources due to limited cultivable land and water, compounded by uneven rainfall distribution affecting fodder growth. Of particular concern is the deficiency in green fodder, which is highly perishable and unsuitable for distant transportation or import due to rapid deterioration. Thus, importing green fodder isn't a viable solution. To bridge the gap between demand and supply, it's imperative to focus on improving forage production and yield.

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Oats (*Avena sativa* L.), a grassy plant belonging to the Gramineae family, hold promise as a solution. It can thrive under both irrigated as well as rainfed conditions in various Indian regions (Rajesh *et al*. 2022). Oats require cooler temperatures during vegetative stages and warmer temperatures during reproductive phases. Offering early availability, high yield, palatability, and nutritive value, oats are rich in protein, vitamin B, energy, phosphorus, and iron. Its fodder can be conserved as silage and hay to address scarcity issues (Choudhary and Prabhu 2016, Poonia *et al*. 2020). With such attributes, oats have substantial potential to enhance fodder availability, improving the health and milk yield of dairy animals (Jehangir *et al*. 2017). Furthermore, the quality grains enable dual-purpose cultivation. Due to their nutritive value, oat-based food products are gaining rapid popularity and are consumed in various forms like probiotic drinks, bread, cookies, biscuits, breakfast cereal flakes, baby food etc. Recent studies have established oats as suitable diet for celiac patients as well (Rasane *et al*. 2015).

Considering all these issues, oats emerge as a promising solution, offering valuable characteristics that can improve the overall fodder availability, benefiting livestock health and productivity while potentially serving as a dual-purpose cereal.

MATERIALS AND METHODS

A field experiment was conducted during winter (*rabi*) seasons of 2018–19 and 2019–20 at research farm of Sher-e-Kashmir University of Agricultural Sciences and Technology Jammu, Jammu and Kashmir (32°40' N and 74°82' E, with an elevation of 293 m amsl). The region experiences a subtropical climate characterized by hot and humid summers during the *kharif* season, followed by cold winters in the *rabi* season. The soil at the experimental site was sandy clay loam in texture, slightly alkaline in reaction (*p*H 7.87), with an electrical conductivity of 0.17 dS/m. It had low organic carbon content (4.57 g/kg) and available nitrogen (227.65 kg/ha), while being moderate in available phosphorus (12.81 kg/ha) and available potassium (131.22 kg/ha). The average annual rainfall for the experimental site was 1115 mm, with 253.4 mm recorded during the crop growth period. Crop sowing was performed using the *kera* method, with a row-to-row spacing of 20 cm, and a seed rate of 100 kg/ha. Fertilization of the crop was carried out with 100 kg of nitrogen (N), 40 kg of phosphorus pentoxide (P_2O_5), and 40 kg of potassium oxide (K_2O) per ha, utilizing Urea, Diammonium phosphate (DAP), and Muriate of Potash (MOP), respectively.

In accordance with standard agricultural practices, the complete doses of phosphorus and potassium, in addition to one-third of the required nitrogen, were applied as a basal dose at the time of sowing. Another one-third of the nitrogen was applied in the first split at 30 days after sowing (DAS). In the case of the single cut treatments, the remaining nitrogen was applied subsequent to the first cut, which occurred at 60 DAS. In contrast, for the double cut treatments, the remaining nitrogen was evenly divided into two equal portions and applied after both the first cut at 60 DAS and the second cut at 105 DAS. Harvesting of all treatments at various growth stages was executed manually using sickles. Recognizing the significant adverse effects of weeds on the overall quality and productivity of fodder crops, a pre-emergence herbicide, Pendimethalin, was applied at a rate of 1.0 kg active ingredient per ha (1.0 kg a.i./ha) using a knapsack sprayer equipped with a flat fan nozzle. This herbicide application was carried out within 24 h of sowing to control the initial flushes of the weeds. To manage subsequent weed flushes that appeared after the effects of Pendimethalin had dissipated, manual hoeing was conducted at 30 DAS. This manual intervention not only facilitated the removal of existing weeds but also promoted soil aeration, which, in turn, led to improved root development. Weeds that emerged at later stages were either manually uprooted or removed using sickles from the experimental plots.

The experiment was laid out in randomized block design with 14 treatments and were replicated thrice. Seven dual purpose oat cultivars, viz. JHO-99-1, JHO-822, JHO-2010-1, JHO-2009-1, JHO-851, JHO-2000-4 and JHO-992 were cultivated under two cutting managements, viz. Single cut at 60 DAS and Double cut at 60 DAS and 105 DAS. All the cultivars were released from ICAR-IGFRI, Jhansi.

Forage yield was recorded after each cut while grain yield, straw yield, grain equivalent yield and yield attributes, viz. no. of tillers/m^2, grains/panicle and 1000-grain weight were recorded at maturity. The net returns were computed by deducting the total cost of cultivation from the gross returns and Benefit: Cost (B:C) ratio was calculated by dividing the gross returns with the cost of cultivation. The data recorded during the course of investigation were tabulated and subjected to analysis of variance techniques as described by Cochran and Cox (1963).

RESULTS AND DISCUSSION

Yield attributes and yield: Yield attributes and yield were greatly affected by both cutting management as well as dual purpose oat cultivars. Perusal of data revealed that superior number of tillers, grains/panicle and 1000-grain weight were recorded in single cut treatments when compared to double cut treatments (Table 1). This might be attributed to gradual decrease in number of tillers after every cut owing to failure of every tiller to regenerate which led to gradual decrease in number of tillers after each cut. Moreover, additional cut taken at the 105 DAS in double cut treatments imposed a constraint on the cumulative growing degree-day accumulation required by plants to complete their life cycle. This reduction in growing degree days accumulation in double cut treatments which is critical for orchestrating various physiological processes, particularly impeded the efficient translocation of photosynthates, primarily carbohydrates, from the source, typically the leaves, to the sink which are developing grains. This disruption in photosynthate partitioning and the subsequent decline in nutrient allocation towards grain development manifested as a pronounced reduction in both the number of grains per panicle and 1000-grain weight. A similar trend of reduction in yield attributes with increasing number of cuttings in oat was also reported by Thamer and Al-Refai (2019) where no cut treatments recorded highest 1000-grain weight which were followed by single cut treatments. However, two cut recorded least 100 grain weight among all cutting managements. Similarly, Singh *et al*. (2014) and Meghraja *et al*. (2023) observed that every day delay in cutting of oat resulted in gradual reduction of all the yield attributes in the oat crop.

Among dual purpose oat cultivars, JHO-2010-1 recorded significantly higher grains/panicle in both single and double cut management treatments. While oat cultivar JHO-851 recorded significantly highest no. of tillers/m^2 in both single and double cutting management respectively. This might be attributed to superior regeneration capability of JHO-851 which resulted in higher no. of tillers/m^2. These findings were similar to the findings as reported by Jehangir (2012) and Palsaniya *et al*. (2015). On the other hand, dual purpose oat cultivar JHO-822 recorded significantly higher 1000-grain weight in both single and double cut management system.

Data pertaining to grain yield was recorded at maturity of the crop and it was observed that increase in cutting

Table 1 Effect of cutting managements on yield attributes of dual purpose oat cultivars (Pooled data of 2 years)

Treatment	No. of tillers/m^2	Grains/panicle	1000-grain weight (g)
Single cut oat cultivar JHO-99-1	253.3	19.20	28.41
Single cut oat cultivar JHO-822	171.3	23.82	36.54
Single cut oat cultivar JHO-2010-1	199.3	37.70	32.91
Single cut oat cultivar JHO-2009-1	177.0	24.10	33.22
Single cut oat cultivar JHO-851	377.3	31.20	16.07
Single cut oat cultivar JHO-2000-4	256.4	19.79	33.80
Single cut oat cultivar JHO-992	202.6	26.87	27.92
Double cut oat cultivar JHO-99-1	90.7	14.57	27.00
Double cut oat cultivar JHO-822	84.2	12.50	31.22
Double cut oat cultivar JHO-2010-1	92.0	19.07	30.77
Double cut oat cultivar JHO-2009-1	87.1	18.60	26.54
Double cut oat cultivar JHO-851	226.7	12.00	15.47
Double cut oat cultivar JHO-2000-4	155.1	7.65	31.15
Double cut oat cultivar JHO-992	65.2	12.33	29.66
SEm(±)	8.1	0.70	0.90
CD (P=0.05)	23.6	2.04	2.60

numbers severely affected grain yield in all the cultivars. Double cut treatments had noteworthy reduction in grain yield in comparison to single cut treatments (Table 2). Dominance of single cut treatments in all of the yield attributing characters is the driving force behind superior grain yield than double cut treatments. This reduction in grain yield with increased cuttings is in accordance with the findings of Kumawat *et al.* (2016) where no cut pearl millet treatments recorded highest grain yield followed by single cut treatments and lastly double cut treatments. Pathan *et al.* (2020) also reported that every delay in cut in oats, barley and wheat at vegetative stage result is severe reduction in grain yield. Highest grain yield was reported when no cut was taken followed by cut at 50, 60 and 70 DAS in decreasing order. Difference in grain yield among the cultivars were also observed and JHO-851 recorded significantly higher grain yield among both single cut and double cut managements. Quick and fast regeneration capacity of the cultivar JHO-851 as compared to other cultivars might be attributed for its higher grain yield in both cutting managements. Fast regeneration of JHO-851 resulted in more time period availability for sufficient vegetative

Table 2 Effect of cutting managements on yields of dual purpose oat cultivars (Pooled data of 2 years)

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Forage yield (t/ha)	Grain equivalent yield (t/ha)
Single cut oat cultivar JHO-99-1	0.58	2.40	19.55	14.49	3.08
Single cut oat cultivar JHO-822	0.78	2.02	27.81	13.01	2.99
Single cut oat cultivar JHO-2010-1	0.90	2.91	23.62	15.44	3.63
Single cut oat cultivar JHO-2009-1	0.70	3.28	17.64	12.84	3.17
Single cut oat cultivar JHO-851	1.11	2.41	31.46	6.50	2.52
Single cut oat cultivar JHO-2000-4	0.76	3.16	19.48	16.27	3.67
Single cut oat cultivar JHO-992	0.74	3.02	19.80	11.50	2.97
Double cut oat cultivar JHO-99-1	0.28	2.42	10.55	28.65	4.69
Double cut oat cultivar JHO-822	0.33	1.13	22.70	30.97	4.78
Double cut oat cultivar JHO-2010-1	0.37	2.49	12.88	35.29	5.70
Double cut oat cultivar JHO-2009-1	0.39	2.67	12.85	31.51	5.25
Double cut oat cultivar JHO-851	0.43	2.35	15.52	26.74	4.57
Double cut oat cultivar JHO-2000-4	0.39	2.98	11.55	39.37	6.37
Double cut oat cultivar JHO-992	0.21	0.69	23.12	27.92	4.14
SEm(±)	0.02	0.11	0.75	0.95	0.13
CD (P=0.05)	0.07	0.32	2.19	2.76	0.38

growth which might have resulted in higher grain yield.

A remarkable difference in straw yield was also observed due to cutting managements. Double cut treatments recorded lower straw yield which might be attributed to poor vegetative growth owing to the lower tillering of the crop because of reduced regeneration after second cut at 105 DAS. These findings are in close conformity with the findings of Kumawat *et al.* (2016) where increase in number of cuttings of bajra resulted in subsequent reduction in straw yield. Among dual purpose oat cultivars JHO-2009-1 and JHO-2000-4 recorded highest straw yield in single and double cutting managements respectively (Table 2). It was also observed that double cut treatments led to a decrease in both grain and straw yields. However, upon closer examination of the data, it clearly became evident that the reduction in grain yield was more pronounced compared to the decline in straw yield. This rapid decline in grain yield had a substantial adverse effect on the crop's harvest index, which represents the ratio of the economic yield (grain yield) to the biological yield of the crop. The rapid decrease in grain yield within the context of double cut treatments resulted in a noticeable reduction in their harvest index. However, as an exception, oat cultivar JHO-992 recorded higher harvest index in double cut treatment than single cut treatment. This increase occurred because of severe reduction in straw yield in double cut treatment ultimately resulting in increased harvest index. Among dual purpose oat cultivars, JHO-851 and JHO-992 recorded significantly higher harvest index in single and double cutting managements respectively (Table 2).

Forage and grain equivalent yield: Upon rigorous examination of the data, it became evident that there was a noteworthy increase in forage and grain equivalent yield in the double cut treatments in comparison to the single cut treatments. This enhancement can be attributed to the supplementary forage yield obtained from the cut taken at 105 DAS. Comparable findings were also documented by previous studies conducted by Alipatra *et al.* (2012) where oat treatments with two cut at 60 and 105 DAS outperformed single cut treatments with cut at 80 DAS. Similarly, Sannagoudar *et al.* (2017) and Jehangir *et al.* (2013) also reported that double cut treatments of oat resulted in 15.47% and 22.69% higher fodder yield respectively than single cut treatments. Despite observing a reduction in both grain and straw yields within the double cut treatments, the introduction of an additional cut at 105 days after sowing (DAS) not only enhanced forage yield but also ameliorated the grain equivalent yield by mitigating the diminished grain production associated with double cut treatments. Notably, among the various cultivars examined, JHO-2000-4 exhibited significantly elevated forage and grain equivalent yields in both single and double cut management systems (Table 2).

Relative economics: Dual-purpose oat cultivars did not impact the overall cost of cultivation, however, cutting management somewhat affected cost of cultivation where double cut management strategy resulted in slightly increased cost of cultivation across all treatments due to additional cut taken at 105 DAS. Notably, the double cut treatments exhibited numerically higher gross returns, net returns, and the benefit:cost (B:C) ratio, indicating their potential for improved economic viability. Among the dual-purpose oat cultivars, JHO-2000-4 displayed the highest numerical values for gross returns, net returns, and the B:C ratio in both the cutting management systems, followed by JHO-2010-1 (Table 3).

The performance of oat crop was profoundly influenced by the interplay of cutting management as well as the choice of dual-purpose cultivars. The study revealed that the manner in which oats were managed, whether through a single cut or double cut approach, had a significant influence on their overall crop productivity. In the case of single cut treatments, oats exhibited superior yield attributes, delivering robust grain and straw yields. Conversely, double cut treatments

Table 3 Effect of cutting managements on relative economics of dual purpose oat cultivars (Pooled data of 2 years)

Treatment	Cost of cultivation (₹)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio (₹/₹)
Single cut oat cultivar JHO-99-1	29457	56304	26847	1.91
Single cut oat cultivar JHO-822	29457	54580	25123	1.85
Single cut oat cultivar JHO-2010-1	29457	66401	36944	2.25
Single cut oat cultivar JHO-2009-1	29457	57868	28411	1.96
Single cut oat cultivar JHO-851	29457	45802	16345	1.55
Single cut oat cultivar JHO-2000-4	29457	67072	37615	2.28
Single cut oat cultivar JHO-992	29457	54186	24729	1.84
Double cut oat cultivar JHO-99-1	32642	86426	53784	2.65
Double cut oat cultivar JHO-822	32642	87950	55308	2.69
Double cut oat cultivar JHO-2010-1	32642	104785	72143	3.21
Double cut oat cultivar JHO-2009-1	32642	96494	63852	2.96
Double cut oat cultivar JHO-851	32642	83987	51345	2.57
Double cut oat cultivar JHO-2000-4	32642	117257	84615	3.59
Double cut oat cultivar JHO-992	32642	76320	43678	2.34

demonstrated their effectiveness in terms of producing both forage and grain equivalent yields, coupled with more favorable economic returns, thus highlighting their potential for increased efficiency in resource utilization. Remarkably, within this dynamic context, the dual-purpose oat cultivar JHO-2000-4 emerged as a standout performer, signifying its excellence under both single and double cut management regimes. This versatile cultivar exhibited a remarkable capacity to adapt to varying management approaches, consistently delivering impressive results. Decisively, the study's findings offer valuable guidance to the farmers seeking to optimize their oat crop yields. If the primary objective is to attain a balanced and generous harvest of both grain as well as forage, the versatile JHO-2000-4 oat variety is the ideal choice when employing the single cut management technique. On the other hand, for those primarily focused on maximizing forage yield, adopting the double cut management strategy while cultivating JHO-2000-4 is the recommended course of action. This dual-purpose approach not only enhances forage production but also yields substantially improving economic returns, providing a well-rounded and economically viable solution for oat cultivation.

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