Indian Journal of Agronomy **65** (3): 348–351 (September 2020)

Research Paper

Influence of cutting-management practices for green fodder and grain production in dual-purpose forage crops

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Received: January 2020; Revised accepted: June 2020

ABSTRACT

An experiment was conducted during the winter in (*rabi*) seasons of 2012–13 to 2014–15 to study the performance of dual-purpose forage crops under different cutting management practices in medium black soil of Pune, Maharashtra. The soil had initial soil status of electrical conductivity (EC) 0.52 dS/m, *p*H 7.85 and organic carbon 0.14%. Based on the pooled mean data for 3 years, significantly highest green fodder, dry matter and crude protein yields of 51.49, 8.29 and 0.89 t/ha, respectively, were recorded in 'JHO 822' oat (*Avena sativa* L.) with cutting for fodder at 70 days after sowing and left for seed production as against 29.00, 5.65, 0.63 t/ha in 'RD 2552' barley (*Hordeum vulgare* L.) variety and 25.03, 3.89, 0.41 t/ha in 'VL 829' wheat (*Triticum aestivum* L.). The same treatment combination recorded seed yield of 1.33 t/ha and straw yield of 3.04 t/ha with net monetary returns of ₹1,01,924/ha and benefit: cost ratio of 3.31. It has also revealed that harvesting stage for getting highest green fodder and grain is very important for dual-purpose crops and delayed cutting reduced regrowth and thereby grain yield.

Key words **:** Benefit: cost ratio, Cutting-management practices, Dual-purpose forage crops, Green-fodder yield, Grain yield, Net monetary returns

Oat and barley are important dual-purpose crops for fodder as well as grain, whereas wheat (*Tritium aestivum* L.) for grain purpose. These crops are grown during the winter season in north-western and central India and are now extending to the eastern region also. Oat is mainly cultivated as fodder for animals and also for grain because of its high nutritional and medicinal value. The use of oat grain is now more focused on mining its benefits as a healthy food (Sharma, 2015). The importance of oats in the biochemical and cosmetic industry is also on the rise (Tiwari and Cummins, 2009). Oat production has 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). Oat is now being preferred as a "functional food" as it is rich source of fibres and also has antioxidant properties (Nirmalakumari *et al*., 2013). Barley possesses high total biomass, thus the small and marginal farmers of our country uses green barley fodder for milch animals. Looking at its high total biomass and salt-tolerance nature, there has been an increasing interest in exploiting barley as a dual-purpose cereal which can permit forage production in early season in addition to the grain yield at later stage (DWR, 2010). Suitable high-yielding variety, cutting schedules and mineral fertilization are considered to be most important pre-requisite for realizing higher green fodder as well as grain yield (Thomson *et al*., 2009).

Barley is mainly cultivated for grain which is consumed as feed and raw material in beverage industries. It is also grown as fodder for animals (Verma *et al*., 2005; Sharma, 2002, 2007). It has been shown elsewhere that if wheat or barley is cut close to the ground before the second leaf node develops, that is between 60 and 85 days after sowing, the crop will grow back and go on to produce a grain yield similar to un-cut crops (Padmakumar *et al.,* 2014). The green fodder harvested is a bonus, over and above the grain and straw produced under conventional animal husbandry practices. Looking at the situation of fragmented and small land holdings, efforts are going on to develop high-yielding varieties for dual-purpose cultivation (Singhal *et al.,* 2008), so that farmer can get green fodder as well as foodgrain from the same crop in the same season. Oat and barley have excellent growth, biomass production and quick regeneration after cutting. The potential of both the crops has been recognized for dual-purpose

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cultivation, where regenerated crop is managed for seed/ grain production after first fodder cut. Therefore, selection of suitable varieties is of paramount importance in harnessing the higher fodder and seed yield. Oat, barley and wheat improvement programme in India is successfully developing commercial varieties for dual-purpose cultivation in different agro-ecological situations. Present study was carried out with the objective of testing the potential of oat, barley and wheat for better production and profitability under dual-purpose cultivation in western Maharashtra.

MATERIALS AND METHODS

The experiment was conducted during 3 consiquative years in winters (*rabi*) of 2012–13 to 2014–15 at Central Research Station of BAIF Development Research Foundation, Pune, Maharashtra to study the performance of dual-purpose forage crops under different cutting-management practices. The experimental soil was medium black, having initial soil status of electrical conductivity 0.52 dS/m, *p*H 7.85 and organic carbon 0.14%, very low in available nitrogen (138 kg/ha), moderately high in available P (23 kg/ha) and high in available K (285 kg/ha). The experiment was conducted in split-plot design with 12 treatment combinations, replicated 3 times. The treatment combinations consisted of 3 dual-purpose forage crops, viz., oat 'JHO 822', barley 'RD 2552' and wheat 'VL 829' with 4 cutting-management practices, viz., no cutting, i.e. crop left for seed/ grain production and cuttings for fodder at 50, 60 and 70 days after sowing and left for either seed or grain production. Plot size was kept as 4 m × 3 m, accommodating 4-m-long 10 rows/plot at 30-cm-row distance with seed rate of 100 kg/ha for oat and wheat and 80 kg/ha for barley. Crops were sown during the last week of October every year. A fertilizer dose of 120 : 60 : 40 N : P : K kg/ha was applied to all the crops. The full dose of phosphorus single superphosphate, potassium (murriate of potash) and half dose of nitrogen (urea) were applied as basal dose at the time of sowing and the remaining nitrogen was top-dressed in 2 splits at tillering stage of crop and 10 days after fodder cut to regenerated crop. Crops were irrigated at every 15-day interval. Two hand-weedings were carried out at 25 days after sowing and 15 days after fodder cut to have the crop free from weeds. The cutting of crop was done as per treatments and regenerated crop managed for seed/ grain production. The experimental site has minimum of 7.4°C and maximum of 39.3 °C temperature with 54.30% mean relative humidity during the crops-growth period.

Data on growth attributes like plant height (cm), tillers/ m row length, leaf: stem ratio and forage yield as green and dry were recorded at the time of harvesting of the crops. The plant samples were first air-dried and then heated in oven at 60 °C to constant weight at atmospheric pressure. The loss of weight is considered as moisture and the residue as dry matter. The crude protein yield was calculated by multiplying crude protein percentage with dry matter yield and expressed in t/ha. The seed or grain and straw yields were calculated on the basis of yield obtained from net plot area. A soil fertility status and plant samples were analysed in laboratory by using standard analytical methods described in AOAC (1995). The economics was calculated on the basis of prevailing market prices of green forage, seed/grain and straw. The experimental data recorded for green fodder, seed/grain and straw yield etc. were analyzed by using OPSTAT software available on the CCS Haryana Agricultural University home page.

RESULTS AND DISCUSSION

Performance of dual-purpose forage crops

The performance of dual-purpose forage crops for yield, net monetary returns and benefit: cost ratio is presented in Table 1. Among the different dual-purpose forage crops, 'JHO 822' oat recorded significantly higher green fodder and straw yields of 32.68 and 6.48 t/ha than the other crops, i.e. 'RD 2552' barley (21.72 and 2.36 t/ha) and 'VL 829' wheat (15.34 and 4.22 t/ha) respectively. The same crop recorded higher net monitory returns of ₹88,916/ha with benefit: cost ratio of 3.02 than the other crops. 'VL 829' wheat recorded significantly higher seed or grain yield of 3.10 t/ha than the other crops. Maximization in fodder yield seems to be on account of overall improvement in growth, as evident from taller plant, higher production of tillers which indicate that there was greater availability of growth inputs matching with formation and development of fodder yield components. Similar findings were also reported by Tulsa and Lal (2009) and Rawat (2011).

Effect of cutting-management practices

The effect of cutting-management practices on yield, net monetary returns and benefit: cost ratio is presented in Table 1. The treatment of cutting of fodder at 70 days after sowing and left for seed/grain production resulted in higher green fodder yield of 35.17 t/ha over the other cutting-management practices. Cutting of fodder at 60 days after sowing and left for seed/grain production recorded the highest net monetary returns of 66,126/ha with benefit: cost ratio of 2.53 over other cutting-management practices; however, it was at par with cutting of fodder at 70 days after sowing and left for seed/grain production for green fodder yield; no cutting, i.e. left for seed/grain production for net monetary returns and cutting of fodder at 50 days after sowing and left for seed/grain production and no cutting, i.e. left for seed/grain production for benefit: cost ratio. The delayed harvesting at 70 days after sowing resulted in the highest green fodder yield; however, grain/seed yield

Table 1. Performance of dual-purpose forage crops under different cutting-management practices (pooled data of 3 years)

Treatment	Yield (t/ha)			Net monetary returns (×10³₹/ha)	Benefit: cost ratio
	Green fodder	Seed/ Grain	Straw		
Dual-purpose forage crops					
'JHO 822' Oat	32.68	2.36	6.48	88.91	3.02
'RD 2552' Barley	21.72	1.67	2.36	33.40	1.77
'VL 829' Wheat	15.34	3.10	4.22	57.82	2.38
SEm±	0.32	0.06	0.11	2.04	0.04
CD (P=0.05)	1.29	0.23	0.46	8.23	0.18
Cutting-management practices					
No cutting, i.e. left for seed/grain production	0.00	4.30	8.06	63.46	2.48
Cutting of fodder at 50 days after sowing and left for seed/grain production	23.44	2.41	4.26	60.96	2.42
Cutting of fodder at 60 days after sowing and left for seed/grain production	34.38	1.80	3.21	66.12	2.53
Cutting of fodder at 70 days after sowing and left for seed/grain production	35.17	0.99	1.88	49.63	2.14
SEm±	0.38	0.05	0.09	1.69	0.03
CD (P=0.05)	1.14	0.14	0.28	5.07	0.11
Interactions (dual purpose forage crops × cutting-management practices)					
Dual-purpose forage crops × cutting management practices	2.14	0.11	0.23	9.98	0.22
CV (%)	4.79	8.20	9.13	11.78	4.05

Table 2. Interaction effects of dual-purpose forage crops under different cutting management practices (pooled data of 3 years)

Treatment combinations (Dual-purpose forage crops with Cutting-management practices)	Yield (t/ha)					Net monetary returns (×10³₹/ha)	Benefit: cost ratio
	Green fodder	Dry-matter	Crude protein	Seed/grain	Straw		
'JHO 822' Oat for seed/grain production	0.00	0.00	0.00	4.06	11.82	71.53	2.63
'JHO 822' Oat for cutting of fodder at 50 days after sowing and left for seed/grain production	32.17	3.50	0.32	2.23	5.98	80.51	2.83
'JHO 822' Oat for cutting of fodder at 60 days after sowing and left for seed/grain production	47.07	6.19	0.65	1.83	5.08	101.69	3.31
'JHO 822' Oat for cutting of fodder at 70 days after sowing and left for seed/grain production	51.49	8.29	0.89	1.33	3.04	101.92	3.31
'RD 2552' Barley for seed/grain production	0.00	0.00	0.00	4.34	5.92	59.26	2.37
'RD 2552' Barley for cutting of fodder at 50 days after sowing and left for seed/grain production	23.89	2.98	0.33	1.32	1.87	27.85	1.64
'RD 2552' Barley for cutting of fodder at 60 days after sowing and left for seed/grain production	34.00	4.78	0.57	0.71	0.92	31.08	1.72
'RD 2552' Barley for cutting of fodder at 70 days after sowing and left for seed/grain production	29.00	5.65	0.63	0.30	0.72	15.41	1.36
'VL 829' Wheat for seed/grain production	0.00	0.00	0.00	4.51	6.46	59.61	2.43
'VL 829' Wheat for cutting of fodder at 50 days after sowing and left for seed/grain production	14.26	1.68	0.15	3.70	4.92	74.53	2.79
'VL 829' Wheat for cutting of fodder at 60 days after sowing and left for seed/grain production	22.08	2.87	0.28	2.86	3.65	65.59	2.57
'VL 829' Wheat for cutting of fodder at 70 days after sowing and left for seed/grain production	25.03	3.89	0.41	1.34	1.88	31.55	1.75
SEm±	0.66	0.10	0.01	0.09	0.18	3.17	0.09
CD (P=0.05)	1.94	0.30	0.03	0.26	0.53	9.38	0.22

Crops	Sale price (/t)		
	Green fodder	Seed/ grain	Straw
Oat	1,825	22,500	675
Barley	1,825	22,500	675
Wheat	1,725	20,500	675

was reduced drastically. Significantly higher seed/grain and straw yields of 4.30 and 8.06 t/ha, respectively, were recorded in no-cutting, i.e. left for seed/grain production over the other cutting-management practices. The higher net monetary returns were mainly owing to harvest of higher green as well as grain yield.

It is established fact that, nutrient uptake by the crop largely depends on its growth and development. Primarily, it is a function of dry-matter production and secondarily, the concentration of nutrients at cellular level (Nirmala *et al.,* 2016). Further, the late green fodder cutting also accumulated higher dry matter by virtue of increase in morphological parameters and finally photosynthetic rate. Thus, the observed crop behaviour under present study could be ascribed only to increased biomass and nutrient content which ultimately increased nutrient accumulation in plant parts. For dual-purpose crop, the stage for fodder cutting is most important on which both fodder and seed/grain yield depend. If cut is given early, forage yield will be reduced and if cut is given slight late, plant regeneration and the seed/grain yield will be affected. Delayed cutting reduced the proper regrowth of the crop and resulted in lower seed/grain and straw yield. Similar findings were recorded by Kharub *et al*. (2013).

Interaction effects of dual-purpose forage crops with cutting-management practices

The interaction effect of dual-purpose forage crops with cutting-management practices on yield, net monetary returns and benefit: cost ratio is presented in Table 2. It was observed that *var*. 'JHO 822' oat for cutting of fodder at 70 days after sowing and left for seed/grain production gave higher green fodder, dry matter and crude protein yields of 51.49, 8.29 and 0.89 t/ha, respectively, with net monetary returns of ₹101,924/ha and benefit: cost ratio of 3.31 over the other treatment combinations. Same treatment combination resulted in seed/grain and straw yields of 1.33 and 3.04 t/ha respectively. 'VL 829' wheat gave significantly highest grain yield of 4.51 t/ha; however, it was at par with 'RD 2552' barley (4.34 t/ha) and 'JHO 822' oat (4.06 t/ha) for seed/grain production over other treatment combinations.

It indicated that regeneration capacity of oat was better than barley and wheat; however, seed-production potential of wheat was much higher than that of oat and barley. Economic analysis revealed that, total income received from green fodder, seed/grain and straw yield of oat was ₹101,924/ha; however, in case of barley and wheat, it was ₹59,263 and ₹74,537/ha. Thus, cultivation of dual-purpose oat appeared to be more beneficial than barley and wheat.

In light of the results obtained from this investigation, it was concluded that for securing the maximum fodder and seed/grain production and for getting higher net monetary returns, 'JHO 822' oat as dual purpose under cutting of fodder at 70 days after sowing and left for seed/grain production with recommended dose of fertilizer was found most productive and remunerative.

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