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# PRODUCTION POTENTIAL OF DUAL PURPOSE WINTER CEREALS AS INFLUENCED BY CUTTING MANAGEMENT UNDER MID HILL CONDITIONS OF HIMACHAL PRADESH

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**SUMMARY**

The field experiment was conducted at CSK HPKV, Palampur from 2011-12 to 2013-14 (*Rabi*) for three consecutive years to study the effect of cutting management on dual purpose winter cereals. Oat crop produced 20.9 and 60.9 per cent more green fodder yield than barley and wheat, respectively with respective increase in dry fodder yield of 28.9 and 123.2 per cent. Crops harvested for fodder at 90 DAS produced higher green and dry herbage yields. No fodder cut resulted in reduction in grain yield of oat and wheat. Among crops grain yield of wheat was significantly better than oat and barley. Fodder cut at 70 DAS resulted in higher grain yield of the crops, whereas, fodder cut at 80 or 90 DAS reduced the grain yield of crops significantly. Wheat crop had better grain and straw yield and thereafter had significantly higher values of net returns and B:C ratio. The crude protein content in wheat fodder was at par with oat, whereas, crude protein yield of oat was at par with barley. Earlier harvesting of fodder at 70 DAS had better crude protein content and lower ADF and NDF contents, but further delay in fodder cut decreased the crude protein content and increased the ADF and NDF contents.

**Key words :** Oat green fodder equivalent yield, forage yield, crude protein, ADF and NDF

Livestock is an integral component of farming system and there is a tremendous pressure on availability of feed and fodder for huge livestock population (512 million) of the country. India faces a net deficit of 36% green fodder, 11% dry fodder and 49% feed (Anonymous, 2016). In Himachal Pradesh, the fodder needs of the animals are mostly met out from various fodder resources; such as pastures, natural grasslands, wastelands, by- products of field crops, cultivable fodders, field bunds, fodder trees and shrubs etc. Our state experiences a long lean period of winter from December to early spring months, resulting in scarcity of green and quality fodder, which results in drastic decrease in milk and meat production. Simultaneously, keeping in view the increasing human population, the requirement of grains can also not be ignored. Crops with dual purpose potential *i.e.* fodder as well as grain production, appear a suitable answer to address the problem of fodder and grain and also reducing land competition.

Among winter cereals; oat is mainly grown for fodder purpose, whereas barley and wheat are grown mainly as grain crops. Dual purpose varieties of these crops hold promise for forage and grain production. Oat is a winter season multicut crop, having excellent growth, wider adaptability, capable of producing nutritious and palatable fodder to milch cattle (Pathan *et al.,* 2020). Barley is also one of the main grain crops with several purposes, as animals feed and fodder, malt and a staple food for human consumption, thus the few small and marginal farmers also grow barley as green fodder for milch animals. Dual purpose winter wheat varieties, which can provide green fodder at early growth stage and subsequently grain, can also be an appropriate option. The potential of specific species as dual purpose depends mainly on the environment and management practices *i.e.* time of sowing, scheduling and cutting management etc. Cutting management is the most important factor which affects the re-growth and production potential of species. Therefore, the present investigation was carried out to know the dual purpose production potential of winter cereals *viz*. oat, barley and wheat in relation to cutting management under mid hill conditions of Himachal Pradesh.

## MATERIALS AND METHODS

The present experiment was carried out during three successive *Rabi* seasons (2011-12 to 2013-14) at CSK HPKV, Palampur, Himachal Pradesh, India. Soil was silty clay loam in texture (34.86 % sand, 37.78 % silt and 26.84% clay), acidic in reaction (5.4), high in organic carbon (14.6 g/kg), medium in available nitrogen (229.9 kg/ha), phosphorous (14.1 kg/ha) and potassium (256.7 kg/ha). Twelve treatment combinations consisted of three crops (oat, wheat and barley) with four cutting schedules (No cut for fodder, fodder cut at 70 DAS, fodder cut at 80 DAS, fodder cut at 90 DAS) having three replications in split plot design. The seed of variety "Plp-1" of oat, "BHS-380" of barley, VL-829" of wheat was used for sowing. Crops were sown in lines 22.5 cm apart using seed rate of 100 kg/ha for all the crops. The recommended fertilizer dose of 120:60:30 kg/ha::N:$P_2O_5$:$K_2O$ was used for oat and wheat and 90:60:30 for barley and half of the nitrogen and whole of the phosphorous and potassium was applied at the time of sowing. Further, the remaining half of nitrogen was applied after fodder cut in all the treatments having cutting schedule for fodder purpose, whereas, in no fodder cut treatment remaining half of nitrogen was top dressed 70 DAS. Standard procedures and methods were followed for analysis of plant materials, such as total N was determined by the modified Micro-kjeldahl method (AOAC, 1970). The per cent crude protein was calculated by multiplying per cent nitrogen with a factor of 6.25. Neutral detergent fibre and Acid detergent fibre were estimated by the method suggested by Van Soest and Snifftn, (1984) and Van Soest *et al.,* (1991), respectively. The data for individual years was pooled and subjected to statistical analysis at 5 per cent level of significance according to the methods of Gomez and Gomez, (1984).

## RESULTS AND DISCUSSION

### Growth Parameters

Among the crops, oat crop (52.8 cm) produced significantly taller plants than barley and wheat (Table 1). The genetic potential of different crops might have reflected its effect on plant height of individual crop. Karwasra *et al.,* (2011) also reported significantly better plant height in oat crop. The plant height of crop increased consistently with each delay in forage cut. Forage cut at 90 DAS (57.6 cm) recorded significantly higher values of plant height than forage cut at 70 and 80 DAS. The delay in fodder cut offers more time for vegetative growth of the crop and inturn an increase in plant height of the crop was observed with delay in the cutting. Patel *et al*., (2011) also reported better plant height in oat crop when harvested at maturity than at 30 and 35 DAS.

No significant difference *w.r.t.* number of tillers per meter square was observed among the crops, however, numerically better tiller count was observed in oat crop than barley and wheat. Tiller number of the crops increased with delay in cutting and significantly maximum number of tillers was produced when fodder cut was taken at 90 DAS. Fodder cut of crop at 90 DAS produced 19.6 and 14.6 per cent more

TABLE 1
Effect of treatments on plant height, tiller number and leaf stem ratio and fodder yield

| Treatment | Plant height (cm) | Tiller number | L : S ratio | Green fodder yield (q/ha) | Dry fodder yield (q/ha) |
|---|---|---|---|---|---|
| **Crop** | | | | | |
| Oat | 52.8 | 211 | 0.58 | 109.4 | 18.3 |
| Barley | 46.0 | 198 | 0.55 | 90.5 | 14.2 |
| Wheat | 38.6 | 182 | 0.63 | 68.0 | 8.2 |
| S. Em± | 0.38 | 5.92 | 0.0008 | 1.76 | 0.23 |
| C. D. (P=0.05) | 1.49 | NS | 0.030 | 6.87 | 0.89 |
| Cutting schedule | | | | | |
| Fodder cut at 70 DAS | 34.9 | 180 | 0.65 | 56.1 | 6.1 |
| Fodder cut at 80 DAS | 44.9 | 187 | 0.59 | 76.1 | 11.1 |
| Fodder cut at 90 DAS | 57.6 | 224 | 0.52 | 135.7 | 23.4 |
| S. Em± | 0.56 | 6.38 | 0.0006 | 1.74 | 0.33 |
| C. D. (P=0.05) | 1.73 | 19.68 | 0.020 | 5.37 | 1.01 |

DAS : Days after sowing.

tillers than fodder cut taken at 70 and 80 DAS, respectively. Higher tiller number may be due to more duration provided to the crops for growth in 90 days of cutting for fodder; which might have favoured better tillering expression of the plants. Significantly better tiller count was recorded when oat was harvested at maturity than at 30 or 45 DAS (Patel *et al*., 2011).

Among different crops, significantly higher leaf stem ratio was observed in wheat whereas, significantly minimum value of leaf stem ratio was observed in barley, while remaining at par with oat. Slow initial vegetative growth of wheat as evident from less plant height (Table 1) and reduced stem biomass of the crop resulted in better proportion of leaves per plant. Pathan *et al.,* (2020) also recorded significantly higher leaf stem ratio in wheat than oat and barley. Fodder cut at 70 DAS resulted in significantly more leaf stem ratio as compared to fodder cut at 80 and 90 DAS. The reduction in leaf stem ratio with delay in fodder cut might be due to increase in stem biomass owing to continuous vegetative growth of the plants which resulted in more dry matter accumulation in stem than leaves. Similar results were also reported by Godara *et al.* (2019) and Khalil *et al.* (2011).

## Yield

### Green and dry forage yield

Oat recorded significantly higher green and dry forage yield over barley and wheat, whereas significantly lowest green and dry forage yield was recorded in wheat. The magnitude of increase in green forage yield of oat over barley and wheat was 20.9 and 60.9 per cent, respectively. The magnitude of increase in dry fodder yield of oat crop over barley and wheat was 28.9 and 193.2 per cent, respectively. The growth components like plant height and leaf stem ratio (Table 1) of the crops observed in the present study reflected their effect on green fodder yield of crops. Pathan *et al.,* (2020) also reported significantly higher green and dry forage yield than barley and wheat.

Fodder cut at 90 DAS proved its significant superiority over other cutting schedules by providing 141.9 and 78.3 per cent more green fodder yield and 283.6 and 110.8 per cent more dry fodder yield over fodder cut at 70 and 80 DAS, respectively. The better growth of the crops in terms of plant height and tiller number (Table 1) with the advancement of growing season can be held responsible for higher green forage yield in this treatment. Patel *et al.,* 2013 and Tiwana and Singh, (2012) recorded higher forage yields in oat with advancement of crop growth.

## Quality Parameters

### Crude protein content and yield

An examination of data (Table 2) revealed that among different crops, higher leaf stem ratio indicating more leafiness in wheat might have been resulted in significantly more crude protein content than oat and barley. Among different cutting schedules, fodder cut taken at 70 DAS resulted in higher crude protein content of 10.3 per cent. This treatment had 4.0 and

TABLE 2
Effect of treatments on various quality parameters

| Treatment | Crude protein content (%) | Crude protein yield (q/ha) | ADF content (%) | ADF yield (q/ha) | NDF content (%) | NDF yield (q/ha) |
|---|---|---|---|---|---|---|
| **Crop** | | | | | | |
| Oat | 10.0 | 1.8 | 60.1 | 11.4 | 52.9 | 10.3 |
| Barley | 9.7 | 1.4 | 54.7 | 8.3 | 56.8 | 8.2 |
| Wheat | 10.2 | 0.8 | 63.6 | 5.4 | 61.0 | 5.1 |
| SEm+ | 0.03 | 0.021 | 0.55 | 0.17 | 0.76 | 0.18 |
| CD (P=0.05) | 0.13 | 0.08 | 2.15 | 0.64 | 2.97 | 0.63 |
| Cutting schedule | | | | | | |
| Fodder cut at 70 DAS | 10.3 | 0.6 | 52.1 | 3.2 | 52.4 | 3.2 |
| Fodder cut at 80 DAS | 9.9 | 1.1 | 60.8 | 6.6 | 57.3 | 6.2 |
| Fodder cut at 90 DAS | 9.7 | 2.3 | 65.5 | 15.3 | 61.0 | 14.2 |
| SEm+ | 0.06 | 0.003 | 0.30 | 0.19 | 0.74 | 0.17 |
| CD (P=0.05) | 0.16 | 0.09 | 0.93 | 0.65 | 2.34 | 0.55 |

DAS : Days after sowing.

6.2 per cent more crude protein content than fodder cut taken at 80 and 90 DAS, respectively. The reduced leafiness as evident from reduced leaf stem ratio (Table 1) at 90 DAS might have reduced the crude protein content and further with the more growth of the crop with delay in cutting might have caused dilution of nutritional constituents in the crop {Tiwana *et al.,* (2012) & Malik *et al.,* (2015)}.

Among different crops, oat recorded significantly higher crude protein yield as compared to barley and wheat which might be due to higher dry forage yield of oat crop (Table 1). Oat crop produced 28.6 and 125 per cent more crude protein yield than barley and wheat, respectively. Similar results were also reported by Pathan *et al.,* (2020). The data further indicated that fodder cut at 90 DAS resulted in significantly higher crude protein yield than fodder cut at 70 and 80 DAS. The increase in crude protein yield with fodder cut at 90 DAS over fodder cut at 70 and 80 DAS was 283.3 and 101.1 per cent, respectively. Patel *et al*., (2011) and Jehangir *et al.*, (2013) also observed better crude protein yield in oat with delay in fodder cuts.

**Acid detergent fibre (ADF) & Neutral Detergent fibre (NDF) content**

A perusal of data revealed that wheat contains significantly higher ADF & NDF contents than oat and barley, whereas, significantly minimum ADF & NDF contents were observed in barley fodder (Table 2). Fodder cut taken at 90 DAS produced the fodder having significantly higher ADF & NDF contents than fodder cut at 70 and 80 DAS, whereas, fodder cut at 70 DAS had significantly minimum ADF & NDF contents compared to fodder cut taken at 80 and 90 DAS. Each delay in fodder cutting offered more time for crop to grow, which gave enough time to fiberized the various plant organelles.

**Acid detergent fibre (ADF) & Neutral Detergent fibre (NDF) yield**

Oat crop recorded significantly higher ADF and NDF yield than barley and wheat, which is due to high dry fodder yield of this crop (Table 1). Oat crop produced 37.4 and 111.1 per cent more ADF yield than barley and wheat, respectively. The respective increase in NDF yield was 21.9 and 101.9 per cent, respectively over barley and wheat. Fodder cut at 90 DAS resulted in significantly higher ADF and NDF yield as compared to fodder cut taken at 70 and 80 DAS. The magnitude of increase in ADF yield with fodder cut taken at 90 DAS over the cut taken at 70 and 80 DAS was 378.1 and 131.8 percent respectively. The respective increase in NDF yield was 343.7 and 129 per cent.

**Parameters at maturity**

The better plant height of oat at maturity might be due to quick growth of the crop after regeneration,

TABLE 3
Effect of treatments on plant height, effective tiller numbers at maturity, grain yield, straw yield and oat green fodder equivalent yield, net returns and BC ratio

| Treatment | Plant height (cm) | Effective tiller numbers | Grain yield (q/ha) | Straw yield (q/ha) | OGFEY (q/ha) | Net returns (Rs./ha) | BC ratio |
|---|---|---|---|---|---|---|---|
| **Crop** | | | | | | | |
| Oat | 104.5 | 115 | 21.7 | 54.9 | 374.1 | 46414 | 2.89 |
| Barley | 84.4 | 148 | 21.1 | 49.0 | 305.6 | 38683 | 2.69 |
| Wheat | 91.3 | 110 | 31.9 | 59.5 | 364.2 | 48721 | 3.03 |
| S. Em± | 0.64 | 1.20 | 0.20 | 0.79 | 2.42 | 311 | 0.024 |
| C. D. (P=0.05) | 2.15 | 4.08 | 0.64 | 2.57 | 8.22 | 1058 | 0.08 |
| Cutting schedule | | | | | | | |
| No fodder cut | 109.4 | 119 | 29.3 | 78.8 | 313.8 | 45799 | 3.74 |
| Fodder cut at 70 DAS | 104.2 | 126 | 32.9 | 73.3 | 389.5 | 53507 | 3.46 |
| Fodder cut at 80 DAS | 93.2 | 126 | 24.6 | 51.3 | 334.5 | 42016 | 2.69 |
| Fodder cut at 90 DAS | 82.7 | 121 | 17.3 | 38.7 | 319.9 | 38296 | 2.47 |
| S. Em± | 1.04 | 1.88 | 0.42 | 0.75 | 3.52 | 615 | 0.05 |
| C. D. (P=0.05) | 3.11 | 3.11 | 1.24 | 2.33 | 10.47 | 1827 | 0.14 |

DAS : Days after sowing.

whereas, the plant height of barley was significantly less than wheat and oat (Table 3). The better plant height of oat than barley and wheat was also reported by Pathan *et al.,* (2020). The data further indicated that significantly taller plants of crops were noticed when no fodder cut was taken, whereas significantly less plant height was recorded when crops were left for seed production after 90 DAS. The reduction in plant height with fodder cut compared to no cut system may be due to the fact that cutting caused termination of growth and the new growth of stems could not reach the same height due to shorter growth time (Khalil *et al.,* 2011).

Barley produced significantly more number of effective tillers as compared to oat and wheat, whereas significantly lower number of effective tillers $m^{-2}$ was observed in wheat. The genetic behaviour of individual crop *w.r.t.* their growth and development might have reflected their effect on effective tiller number of crops observed in the present study. Minimum number of effective tillers was recorded under no cut system and maximum value of effective tillers $m^{-2}$ was noticed when crops were allowed to regenerate after fodder cut taken at 70 DAS and further delay in cutting showed a decreasing trend w.r.t. the number of effective tillers per unit area.

**Grain and Straw yield**

Wheat recorded significantly higher grain and straw yield as compared to oat and barley, whereas, barley recorded significantly lower straw yield as compared to oat and wheat (Table 3). The magnitude of increase in grain yield of wheat over oat and barley was 47.0 and 51.2 per cent, respectively. The respective increase in straw yield was 8.4 and 21.4 per cent. The highest grain yield of wheat than barley and oat was also reported by Godara *et al.,* (2019). The data further indicated that fodder cut at 70 DAS recorded significantly higher grain yield as compared to no cut and fodder cut at 80 and 90 DAS. Fodder cut at 70 DAS after sowing resulted in the production of 12.3, 33.7 and 90.2 per cent more grain yield over no fodder cut and fodder cut taken at 80 and 90 DAS, respectively. The respective increase in straw yield with no fodder cut was 7.5, 53.6 and 103.6 per cent over fodder cut at 70, 80 and 90 DAS, respectively. The grain yield of the crops was in accordance with the yield attributing characters (Table 1) of respective crops in the present study. The lower grain yield in no cut treatment as compared to fodder cut at 70 days after sowing was due to heavy lodging losses in no cut treatment. The cutting management must be managed in such a way that the crop left for seed production can coincide with favourable climatic conditions for profuse flowering and seed setting. Similar results were also reported by Kumar and Dudi, 2010, Patel *et al.,* 2011 and Patel *et al.,* 2013.

**Oat green fodder equivalent yield (OGFEY)**

The data showed that oat recorded significantly higher oat green fodder equivalent yield (374.1 q/ha) as compared to barley and wheat (Table 3). The magnitude of increase in oat green fodder equivalent yield with oat crop over barley and wheat was 22.4 and 2.7 per cent, respectively. Significantly higher grain yield of oat (Table 3) has reflected its effect on better oat green fodder equivalent yield observed under this treatment. Further, cut at 70 DAS owing to higher grain yield resulted in significantly higher oat green fodder equivalent yield (389.5 q/ha) as compared to no cut and cut at 80 and 90 DAS. Fodder cut at 70 DAS resulted in 24.1, 16.4 and 21.7 per cent more oat green fodder equivalent yield over no fodder cut and fodder cut taken at 80 and 90 DAS.

**ECONOMICS**

A perusal of data showed that significantly higher net returns of Rs. 48721/ha were obtained in wheat crop (Table 3). Wheat crop has Rs. 2307/ha and Rs. 10038/ha more net returns than oat and barley. The better net return in wheat can be ascribed to higher oat green fodder equivalent yield obtained under this treatment. Due to better net returns, significantly higher value of B:C ratio was also observed in wheat, followed by oat, whereas barley had significantly minimum net returns (Rs. 38683/ha) and B:C ratio 2.69 compared to oat and wheat in the present study. Godara *et al.,* (2019) also recorded significantly higher net returns and BC ratio in wheat than oat and barley.

Observation of data (Table 3) also indicated that crops after one fodder cut taken at 70 DAS resulted in significantly highest net return (Rs. 53507/ ha), whereas, significantly highest BC ratio (3.74) was observed with no fodder cut system. Fodder cut after 70 DAS on one hand provided green fodder during lean months of winter and on another proved economically better by providing Rs. 7708/ha, Rs. 11491/ha and Rs. 15211/ha more net returns than no fodder cut and fodder cut taken at 80 and 90 DAS, respectively. The fodder yield, grain yield, straw yield and ultimately oat green fodder equivalent yield obtained

under different treatments reflected their effects on net return and BC ratio in respective treatments.

## CONCLUSION

The green and dry herbage yield of all the crops increased consistently with advancement of the growth of crops upto 90 days after sowing. Oat crop produced more forage yield, crude protein content and crude protein yield than barley and wheat, whereas, barley produced lower ADF and NDF content than oat and wheat. Fodder cut at 70 DAS produced higher crude protein content and lower ADF and NDF content than rest of the cutting regimes. Wheat crop had significantly better grain, straw and oat green fodder equivalent yield, net returns and BC ratio than barley and oat. Fodder cut at 70 DAS proved superior from grain yield, oat green fodder equivalent yield and net returns point of view, whereas, significantly higher straw yield and BC ratio was obtained under no fodder cut system.

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