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NUTRITIVE VALUATION OF WINTER FORAGE CEREALS HAY UNDER VARIABILITY OF AGRO-CLIMATIC CONDITIONS AND NITROGEN REGIMES AT BOOTING STAGE

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ABSTRACT

The fundamental relation between forage growers of rain fed areas of Azad Jammu and Kashmir and Pakistan is intense fodder shortage in winter season. The study focused to investigate the inconsistency of winter forage cereals WFCs (barley, oat, rye and triticale) to compute precise dose of nitrogen (0, 75, 150 and 225 kg.ha^{-1}) for the assessment of nutritive evaluation of WFCs, hay at booting stage BS under temperate conditions of (Rawalakot) and subtropical conditions of (Rawalpindi). The two years (2016-2017, 2017-2018) field experiments were, examined at research farm (Chottagalla) of University of Poonch Rawalakot and research farm of (Koont) Arid Agriculture University Rawalpindi. In both locations at BS, the hay samples were properly harvested, tagged and arranged. During corresponding years, Rye (12.9%, 13.1%) at Rawalakot while oat (11.2%, 11.5%) at Rawalpindi produced more crude protein contents in response with N @ 225 kg ha^{-1}. The extreme amount of crude fiber contents, acid detergent fiber and neutral detergent fiber contents were documented, for rye at Rawalakot, whereas for oat at Rawalpindi conditions in response to N @ o kg ha^{-1}. Throughout both years, the highest ash contents were recorded, for rye (13.27%, 13.48%) at Rawalakot, whereas triticale (11.42% 12.11%) and oat (11.2%, 11.89) were statistically same under Rawalpindi conditions with application of N @ 225 kg ha^{-1}. It is concluded; from experimental results, there is dire need for nitrogen application to optimize the yield and nutritional value of WFCs under both climatic conditions.

Keywords: Forage cereals, Temperate conditions, Barley, Oat, Rye.

INTRODUCTION

Good quality fodder is provided by cereal crops, which largely depends on soil and climatic conditions, composition of grasses, regime of its usage, fertilizers, etc. (Kovtun, 2016). Winter cereal crops provide the main part of forage yield, in particular with sufficient moisture under particular climatic conditions (Panakhyd, 2017; Karbivska, 2020). Hay are a source of high quality and cheap fodders for livestock. Hay remains one of the main fodders in the diets of animals. It is the only roughage containing vitamin D, which regulates mineral metabolism in animal organism (Katsumata, 2018). The most significant impact on the quality of fodder, in particular on the indices of biochemical composition, has fertilization and usage, as well as the species composition of grasses, which is usually oriented on when preparing rations for feeding highly productive livestock (Litvinov, 2019). Fertilizer application is one of the most effective measures of haymaking improvement, which caused the targeted changes in growing conditions (Teberdyev, 2015; Karbivska, 2019). Some researchers reported that the fodder of cereals and legumes contains up to 30% fiber, and its content depends on the botanical composition, fertilizer and mowing time (Mashchak, 2013; Vasile, 2016). Fiber in a certain amount is an important factor that normalizes digestion in the rumen of animals, but its excessive content in the diet reduces digestibility and efficiency of nutrient use by animals (Demydas, 2016; Kokovikhin, 2020).

Production and preservation of winter forage cereals crops in rainfed areas of AJ&K and Pakistan having socio-economic barriers for farmers' community. The most critical constraints regarding to this issue is dawdling quantity of scientific knowledge, development and insufficient care about livestock feeding subject (jamil et al., 2021). Livestock is the principal subsector in agriculture that added 60.84 percent to the agriculture value addition and 14.63 percent to the GDP during FY2024. Furthermore, this sector supported more then eight million rural families, which are directly involve in livestock production that earns 40 percent of their economic requirements from this source (Govt. of Pakistan, 2023-24). The N deficiency is one of the major constraints in actual farming of temperate and subtropical rainfed climatic conditions (Campbell et al., 1993; Barati and Ghadiri, 2017). Therefore, supplemental chemical N fertilizers are most widely used for such systems because rate of release of N in soils often does not match crop demand with fertilizer applications. Moreover, highly concentrated inorganic N inputs can have detrimental environmental impacts (Campbell et al., 1995). Although many studies concerning winter forage cereals and nitrogen in relation to different climatic conditions have not been fully investigated. Keeping in view the constraints of experiment the main objective of this study was to evaluate the suitable WFCs and rate of N application in relation to different agro- climatic conditions of Rawalakot and Rawalpindi.

MATERIALS AND METHODS

Field research was worked out for nutritive valuation of winter forage cereals hay under variability of agro-climatic conditions and nitrogen regimes at booting stage during rabi season 2016-17, 2017-2018 at PMAS Arid Agriculture University Research Farm (latitude 33.3° N, longitude 73.3° E, and 460 (masl) with annual rainfall of 775 mm) Chakwal road Rawalpindi (sub-tropical). The same set of experiment was carried out at research farm of University of Poonch Rawalakot (temperate) (latitude 33.51°N, longitude 73.45° E, elevation with 1638 (masl) with annual rainfall of 850 mm): (Jamil et al., 2021). During each year winter, forage cereals were sown on 24th Oct 2016- 2017 in Sub-tropical while on 2nd Nov at Temperate conditions. Crops was sown with hand drill at a row spacing of 22.5 cm. All the cultural management were uniform at both locations except treatments. Nitrogen was applied in between the rows of respective crops. Replications were separated from each other by one meter. Treatments included four winter forage cereals i.e. Barley, Oats, Rye and Triticale and four nitrogen levels (0, 75, 150 and 225 kg.ha-1). The experiment was laid-out, in factorial arrangement of randomized complete block design (RCBD) and was replicated thrice. The net plot size was maintained at 12 m^2. The crops were harvested at BS, while harvested forage was preserved in hay form for three weeks.

The winter forage cereals were harvested manually by means of sickle at booting stage. Among winter cereals, barley reached booting stage at the earliest (106 DAS) days after sowing which was followed by oat (110 DAS). Furthermore, triticale followed the suit (116 DAS) of oat while rye (122 DAS) attained booting stage after rest of cereals.

For conducting quality analysis of hay, samples (500 gm for each treatment) were dried in oven for 48 hours at 65 ℃ and were grinded using 2 mm sieve of Willy mill at booting stage. Following quality traits studied after process completion of hay. Crude protein (%), crude fiber (%), acid detergent fiber, neutral detergent fiber and ash were also determined through standard procedure (AOAC, 2012). The recorded data were subjected to analysis of variance technique using statistical software package "Statistix 8.1 version" (Steel et al., 1997). The significance of the treatment means was determined by using Tukey's Honest Significant test at 5% level of probability.

RESULTS AND DISCUSSION

Results indicated significant interaction of winter forage cereals WFCs and nitrogen levels for CP contents at booting stage. Throughout both years of experiment, the highest CP contents were illustrated in rye with response to N_3 (12.9, 13.1) at temperate conditions of Rawalakot whereas the extreme CP contents were found in oat with response to N_3 (11.2, 11.5) under subtropical climatic conditions of Rawalpindi. Significant variability for CP contents in presence of nitrogen was might be due to more leaf area which captured more photo assimilates and relative performance of each crop. At early stage plant, avail more nutrients from soil that ultimately effect protein contents of each crop. Results were in line with that of Cinar, Ozkurt & Cetin (2019) that highest CP yields was obtained, @ of 250 kgha^{-1} N application for rye grass under variability of years and climatic conditions (Table 1). Additionally, Ronga et al. (2020) also concluded that there is significant disparity for CP yield of wheat at early growth stage. Nitrogen is the basic constituent of proteins nucleic and amino acid which directly affects protein contents due to different doses of nitrogen application. Additionally, the role of the nitrogen in amino acids synthesis, N fertilization enhance the vegetative growth, thus, increases the leaf to stem ratio of canopy. Increasing N fertilization, therefore, resulted in significant increases in forage CP contents. Similar results were reported by Van-Soest, (1982) and Domenico et al. (2020) that winter wheat harvested at heading gave more CP contents as compared to grain milk and grain dough stage.

Table 1: Winter forage cereals hay CP, CF and ADF contents influenced by varying nitrogen regimes at booting stage under temperate and subtropical condition during 2016-17 & 2017-18.

RKT	Crops	N_0	N_1	N_2	N_3	N_0	N_1	N_2	N_3
		CP contents 2016-17				CP contents 2017-18			
	Barley	7.3k	9.0ij	9.4hij	10.4fg	7.6k	9.1j	9.6i	10.2gh
	Oat	7.8k	8.9j	9.8gh	11.2de	7.9k	9.0j	9.9hi	11.3d
	Rye	10.4fg	11.7cd	12.5ab	12.9a	10.5fg	11.9c	12.7ab	13.1a
	Triticale	9.67hi	10.6ef	11.0ef	12.1bc	9.7i	10.7ef	11.1de	12.3bc
RWP	Barley	7.9i	8.5fg	9.5d	10.6b	8.1gh	8.6fgh	9.7cde	10.8ab
	Oat	8.3gh	9.0e	10.1c	11.2a	8.5fgh	9.2def	10.4bc	11.5a
	Rye	6.8k	7.5j	8.4fg	8.9e	7.2i	8.0hi	9.0efg	9.1ef
	Triticale	8.0hi	8.7ef	9.8d	11.0a	8.2gh	8.9efg	10.0bcd	11.26a
		CF contents 2016-17				CF contents 2017-18			
RKT	Barley	22.6efg	21.8g	21.5g	18.7h	23.1efg	22.2fg	21.8g	19.0h
	Oat	24.6cd	23.5def	22.8efg	22.3fg	25.0cd	23.8def	23.1efg	22.6fg
	Rye	27.6a	27.5a	26.7ab	26.3ab	28.1a	27.9ab	27.1ab	26.7abc
	Triticale	26.7ab	25.8bc	24.0de	22.7efg	27.1ab	26.2bc	24.4de	23.0e-g
RWP	Barley	25.6cd	25.4cd	23.8ef	22.3fg	26.1de	25.2ef	23.9fg	22.1h
	Oat	28.6a	28.4a	27.7ab	27.2ab	29.4a	28.7ab	27.9bc	27.3bcd
	Rye	22.4fg	22.1g	21.9gh	20.4h	22.5gh	21.1hi	20.2i	20.1i
	Triticale	27.7ab	26.8bc	25.0de	23.7ef	27.9bc	27.0cd	25.1ef	23.8fg
		ADF contents 2016-17				ADF contents 2017-18			
RKT	Barley	24.4h	23.0i	22.5i	19.3j	24.8g	23.4h	22.8h	19.9i
	Oat	29.1de	28.1ef	27.6f	25.6g	29.6de	28.5ef	28.1f	26.0g
	Rye	32.7a	32.0ab	31.2bc	30.7c	33.2a	32.5ab	31.8bc	31.2c
	Triticale	30.1cd	29.1de	28.1ef	27.6f	30.6cd	29.6de	28.5ef	28.1f
RWP	Barley	29.06cd	27.38e	25.91f	24.81g	27.03g	24.87hi	24.25hij	22.28k
	Oat	31.91a	31.27a	30.37b	29.35c	34.15a	33.46ab	32.64bc	32.01c
	Rye	23.70h	23.39h	21.81i	20.61j	25.29h	23.87ij	23.25jk	21.95k
	Triticale	29.4c	28.39d	27.38e	26.25f	30.36d	29.25de	28.76ef	27.57fg

CP, crude protein: CF, crude fiber: ADF, Acid detergent fiber (N_0@ 0kgha^{-1}: N_1@75kgha^{-1}: N_2 @150kgha^{-1} and N_3@ 225kgha^{-1}) Values having same letters do not differ significantly at 5 % probability level, RKT, Rawalakot: RWP, Rawalpindi

Significant variation among the interaction of WFCs and nitrogen levels was witnessed for CF (%) contents at booting stage. The maximum CF contents were noted, for rye in response to N_0 at temperate conditions of Rawalakot during both years followed by triticale, oat and barley. Alike, under subtropical conditions of Rawalpindi the maximum CF contents were resulted for oat in response to N_0 followed by triticale, barley and rye. As the rate of N fertilization increases the CF contents were declined. Correspondingly, Nori, Halim & Ramlan (2008) reported that urea N fertilization levels from 120 to 240 kgha^{-1} resulted in a linear or quadratic decline in ADF and NDF (both combine ably refers to CF) accumulation in whole rice straw, leaf and stem fractions. Contrary, to present findings Salama & Badry (2021) reported that fiber fractions (NDF and ADF) were non-significantly affected N application.

Significant variation was observed in the interaction of WFCs and nitrogen levels for ADF and NDF (%) contents at booting stage during both corresponding years under temperate and subtropical conditions. During both years of field trial highest ADF and NDF contents were documented in response to N0 followed by N_1, N_2 and N_3. The maximum ADF and NDF contents were noted for rye in Rawalakot and oat in

Rawalpindi premises. The variation was might be due to difference of WFCs variety and application of different nitrogen doses. As reported by Cui et al. (2015) that the NDF and ADF accumulation response might vary depending on crop variety, plantation site, nitrogen fertilizer source and fertilization level. Obour et al. (2019) reported a decrease in fiber fractions (NDF and ADF) in oat forage with use of nitrogen application. Similary, Ben Youssef et al. (2019), reported for triticale grown in Tunisia.

The interaction among crops and nitrogen levels showed significant disparity for ash (%) contents during both years at booting stage. The highest amount of ash contents was verified, for rye (13.27, 13.48 %) at Rawalakot and for oat (11.2, 11.89%) in Rawalpindi during corresponding years of field trial in response to N_3 (Table 2). The ash contents variation was due to different doses of mineral nitrogen and different crop canopy of winter cereals. Nitrogen fertilizer definitely improves vegetative growth thus increase the leaf to stem ratio of the canopy which ultimately affects ash contents of crop. Similar findings were confirmed by Coblentz, Akins, Cavadini & Jokela (2017) that nitrogen fertilizer application prominently increase whole-plant ash compared with forage harvested from unfertilized. Likewise, reported by Obour, Holman & Schlegel (2019) that application of nitrogen significantly increase mineral content of oat forage as minerals are the basic constituent of ash contents.

Table 2: Winter forage cereals hay NDF and ASH contents influenced by varying nitrogen regimes at booting stage under temperate and subtropical condition during 2016-17 & 2017-18.

		NDF contents 2016-17				NDF contents Fiber 2017-18			
RKT	Crops	N_0	N_1	N_2	N_3	N_0	N_1	N_2	N_3
	Barley	43.4e	40.8gh	40.2h	34.1i	44.1ef	41.4g	40.8g	35.3h
	Oat	44.4de	43.3ef	42.9efg	41.1fgh	45.1ef	44.0f	43.5f	41.7g
	Rye	49.4a	48.7a	47.9ab	47.3abc	50.2a	49.5ab	48.7ab	48.1bc
	Triticale	46.1bcd	45.1cde	44.0de	43.6e	46.8cd	45.8de	44.7ef	44.3ef
RWP	Barley	44.9cd	42.9ef	41.9f	39.8g	44.8f	42.4gh	40.9hi	37.9k
	Oat	48.1a	46.8ab	46.3bc	45.4bcd	52.4a	50.1ab	49.2bc	48.3cd
	Rye	39.9g	38.9gh	37.8hi	36.7i	43.5fg	41.4hi	39.9ij	38.3jk
	Triticale	45.6bc	43.9de	43.3ef	42.4ef	48.6c	46.8de	45.4ef	43.9fg
		Ash Contents 2016-17				Ash Contents 2017-18			
RKT	Barley	9.46gh	10.15ef	10.64de	11.30c	9.61g	10.31ef	10.81de	11.39c
	Oat	8.47ij	8.91hi	9.79fg	10.21ef	8.61hi	9.06h	9.95fg	10.37ef
	Rye	10.02fg	10.93cd	12.15b	13.27a	10.18f	11.11cd	12.34b	13.48a
	Triticale	7.28l	7.59kl	7.97jk	8.26j	7.40k	7.72jk	8.1ij	8.4i
RWP	Barley	6.31gh	7.42f	8.31de	10.02c	7.24g	8.03ef	8.94cd	10.52b
	Oat	7.68ef	9.01d	9.89c	11.2a	8.30de	9.66c	10.55b	11.89a
	Rye	6.00h	6.93fg	7.60ef	8.89d	7.2g	7.53fg	8.22d-f	9.53c
	Triticale	8.95d	10.11bc	10.98ab	11.42a	9.59c	10.78b	11.67a	12.11a

NDF, Neutral detergent fiber: Ash Contents (N_0@ 0kgha^{-1}: N_1@75kgha^{-1}: N_2 @150kgha^{-1} and N_3@ 225kgha^{-1}) Values having same letters do not differ significantly at 5 % probability level: RKT, Rawalakot: RWP, Rawalpindi

CONCLUSION

In temperate climatic conditions of Rawalakot rye remains the suitable option as hay with N application of 225 kg ha^{-1}. Furthermore, under subtropical climatic conditions oat is right option for fodder preservation as hay with N application of 225kg ha^{-1}. The study concludes that nitrogen application is essential for improving both the yield and nutritional quality of WFCs under varying climatic conditions.

REFERENCES

AOAC. 2012. Official Method of Analysis. Association of Official Analytical Chemists, Washington, DC, USA.

Barati, V. and H. Ghadiri. 2017. Assimilate and Nitrogen Remobilization of Six-Rowed and Two-Rowed Winter Barley under Drought Stress at Different Nitrogen Fertilization. Arch. Agron. Soil Sci., **63**: 841-855.

BenYoussef, S., S.S. Kachout, S. Abidi, B. Saddem, J. Ismail and H.B. Salem. 2019. Effect of different levels of nitrogen fertilization on forage yields and quality of hairy vetch (V, Roth) Triticale (X, Witmack) Mixtures. The

Open Agriculture Journal, **13**(1), 90-100.

Campbell, C. A., R.J.K. Myers and D. Curtin. 1995. Managing Nitrogen for Sustainable Crop Production. Fertilizer Res., **42**: 277-296.

Campbell, C. A., F. Selles, R.P. Zentner and B.G. Mc Conkey. 1993. Available water and nitrogen effects on yield components and grain nitrogen of zero-till spring wheat. Agron. J., **85**: 114-120

Cinar, S., M. Ozkurt and R. Cetin. 2020. Effects of nitrogen fertilization rates on forage yield and quality of annual ryegrass (*Lolium multiflorum* L.) in central black sea climatic zone in Turkey. Applied Ecology and Environmental Research, **18**(1), 417-432.

Coblentz, W.K., M.S. Akins, J.S. Cavadini and W.E. Jokela. 2017. Net effects of nitrogen fertilization on the nutritive value and digestibility of oat forages. Journal of Dairy Science, **100**(3), 1739-1750.

Cui, Y., Z. Tian, X. Zhang, A. Muhammad, H. Han, D. Jiang and T. Dai. 2015. Effect of water deficit during vegetative growth periods on postanthesis photosynthetic capacity and grain yield in winter wheat (*Triticum aestivum* L.). Acta Physiologiae Plantarum, **37**(10), 1-10.

Demydas H. I. and V. Demtsiura Yu. 2016. Influence of fertilizer level and sowing method on organic matter content in green mass of mixtures of alfalfa and cereals. Silske hospodarstvo ta lisivnytstvo, **3**: 76-83

GOP. 2024. Economic Survey of Pakistan. 2023-24: Chapter 2, Agriculture. Ministry of Food, Agriculture and Livestock Division (Economic wing), Islamabad, Pakistan, pp. 19-30

Jamil, M., M. Ansar, Z. Iqbal, T.A. Ahmed, M. Shehzad, A. Ahmad and I. Mahmood. 2021. Biometric characteristics of winter forage cereals grown under nitrogen fertilization in temperate rain conditions. Revista De La Facultad De Agronomia De La Universidad Del Zulia, **38**(4): 846-866

Karbivska U. M., V.G. Kurgak, V.F. Kaminskyi, A.O Butenko, G.A. Davydenko, O.B. Viunenko, S.M. Vyhaniailo and S.V. Khomenko. 2020. Economic and energy efficiency of forming and using legume-cereal grass stands depending on fertilizers. Ukrainian Journal of Ecology, **10**(2), 284-288

Karbivska U.M., A.O. Butenko, I.M. Masyk, N.S. Kozhushko, V.I. Dubovyk, L.V. Kriuchko, V.P. Onopriienko, I.M. Onopriienko and L.M. Khomenko. 2019. Influence of agrotechnical measures on the quality of feed of legume-grass mixtures. Ukrainian Journal of Ecology, **9**(4), 547- 551.

Katsumata M., H. Kobayashi, A. Ashihara, A. Ishida. 2018. Effects of dietary lysine levels and lighting conditions on intramuscular fat accumulation in growing pigs. Animal Science Journal, **89**(7), 988–993.

Kokovikhin S. V., V.P. Kovalenko, A.A. Slepchenko, O.L. Tonkha, N.O. Kovalenko, A.O. Butenko and V.O. Ushkarenko. 2020. Regularities of sowing alfalfa productivity formation while using different types of nitrogen fertilizers in cultivation technology. Modern Phytomorphology, **14:** 35-39

Kovtun K. P., Y.A. Veklenko and H.O. Kopayhorodska. 2016. Chemical composition and quality of feed of the degradated old grass stands of the meadow lands under different methods of their improvement in the right-bank Forest-Steppe, Feeds and Feed Production, **82**, 204-209.

Kurgak V.G. 2010. Meadow agro phytocenoses. Kyiv. DIA.

Litvinov D.V., A.O Butenko, V.I. Onychko, T. O. Onychko, L.V. Malynka, I.M. Masyk, L.M. Bondarieva and O.L. Ihnatieva. 2019. Parameters of biological circulation of phytomass and nutritional elements in crop rotations. Ukrainian Journal of Ecology, **9**(3), 92-98.

Mashchak Ya. I. and N.M. Rudavska. 2013. Quality and nutritional value of feed mixtures seeded with hay use. Rudavskii Foothill and mountain agriculture and livestock, **55**(2), 81-85.

Nori, H., R.A. Halim and M.F. Ramlan. 2008. Effects of nitrogen fertilization management practice on the yield and straw nutritional quality of commercial rice varieties. Malaysian Journal of Mathematical Sciences, **2**(2), 61-71

Obour, A., J. Holman and A. Schlegel. 2019. Seeding rate and nitrogen application effects on spring oat and triticale forage. Kansas Agricultural Experiment Station Research Reports, **4**(5), 5.

Panakhyd H. Ia. And H.S. Konyk . 2017. Basic indicators of forage quality of leguminous and cereal sown grass. Forages and forage production, **83**, 145-149.

Ronga, D., A. Dal Prà, A. Immovilli, F. Ruozzi, R. Davolio and M.T. Pacchioli. 2020. Effects of Harvest Time on the Yield and Quality of Winter Wheat Hay Produced in Northern Italy. Agronomy. **10**(6): 917.

Ronga, D., D.P. Aldo, I. Alessandra, F. Ruozzi, R. Davolio and M.T. Pacchioli. 2020. Effects of harvest time on the yield and quality of winter wheat hay produced in Northern Italy. Agronomy, **10**(6): 917.

Salama, H.S.A. and H.H. Badry. 2021. Forage and grain yields of dual-purpose triticale as influenced by the integrated use of *Azotobacter chroococcum* and mineral nitrogen fertilizer. Italian Journal of Agronomy, **16**(2), 1719.

Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and procedures of statistics: A Biometrical approach. 3rd ed. McGraw Hill Book Co. New York. pp. 400-428.

Teberdyev D.M. and A.V. Rodyonova. 2015. Efficacy of fertilizing a long-term hayfield. Fodder production, Moscow, **10**, 3-7

Van Soest, P.J. 1982. Nutritional ecology of the ruminant animal. *CUP, Ithaca, NY. USA.*

Vasile, A.J., I.R. Andreea, G.H. Popescu, N. Elvira and Z. Marian. 2016. Implications of agricultural bioenergy crop production and prices in changing the land use paradigm - The case of Romania. Land Use Policy, **50**: 399-407.