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Influence of integrated nutrient management with differential substitution of farm yard manure for nitrogen on growth and growth parameters of dual purpose *rabi* fodders

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Abstract
A field experiment was conducted at the Research Farm of Division of Agronomy of Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, Chatha during the *rabi* season of 2017-18. The soil of the experiment was sandy clay loam in texture, slightly alkaline in reaction, low in organic carbon, available nitrogen and medium in available phosphorus and potassium. The experiment was laid out in randomized block design with 12 treatments and 3 replications. The three different dual purpose *rabi* fodders *viz.* Oats, Barley and Wheat were sown on 25 November, 2017 and were subjected to four integrated nutrient management treatments. The treatments consisted of oats with recommended dose of fertilizers + 25% N through FYM (T_1), oats with 75 % recommended dose of fertilizers + 50 % N through FYM (T_2), oats with 50 % recommended dose of fertilizers + 75% N through FYM (T_3), oats with 25 % recommended dose of fertilizers + 100 % N through FYM (T_4), barley with recommended dose of fertilizers + 25% N through FYM (T_5), barley with 75 % recommended dose of fertilizers + 50 % N through FYM (T_6), barley with 50 % recommended dose of fertilizers + 75% N through FYM (T_7), barley with 25 % recommended dose of fertilizers + 100 % N through FYM (T_8), wheat with recommended dose of fertilizers + 25% N through FYM (T_9), wheat with 75 % recommended dose of fertilizers + 50 % N through FYM (T_{10}), wheat with 50 % recommended dose of fertilizers + 75% N through FYM (T_{11}), wheat with 25 % recommended dose of fertilizers + 100 % N through FYM (T_{12}). Full dose of P and K along with half dose of N as per package practices of individual crop were applied as basal dose through inorganic source of nutrients *viz*. Urea, DAP and MOP respectively and the remaining half was applied in two equal splits at first cut and 30 days after first cut whereas as the different doses of FYM were applied according to the treatments at the time of final land preparation. The experimental results revealed that among different INM treatments, the treatment where RDF+ 25% N through FYM was applied proved superior among all the treatments. However, it was statistically, at par with the application of 75% RDF + 50% N.

Keywords: INM**,** *Rabi* fodders, dual purpose, forage, growth parameters

Introduction
Agriculture is the backbone of Indian economy and about 58 % of the Indian population depends on agriculture (http://www.ibef.org). Due to diverse agro-climatic conditions, the successful production of various types of crops could be possible. Indian soils are famous for production of cereals, pulses, oilseeds, beverages, spices *etc*. However, we are still far behind in the production of forage, both quantitatively and qualitatively for feeding the large livestock population (Sharma, 2008) [7]. At present, the country faces a net deficit of 35.6 per cent green fodder, 10.95 per cent dry crop residues and 44 per cent concentrate feed ingredients (Anonymous, 2015) [1]. But with the decline in the size of agricultural land holdings and growing food security concern, there is no scope to increase the area under fodder production. Cultivation of dual purpose fodder could be a better option to meet out the problems of land shortage and fodder scarcity. Therefore, growing dual purpose cereal forages can serve both the concerns of growing food demand and forage shortage. The gap in the demand and supply of green fodder can be covered up to a certain extent by developing dual purpose cereal varieties (Hundal *et al.*, 2014) [4]. Hence it is very essential to maximize the quantity and quality of dual purpose fodder production per unit area and time by proper management of grassland, pasture and also by utilizing proper agro-techniques for fodder production (Jat *et al.*, 2015) [5]. Cereals like wheat (*Triticum aestivum*), oats (*Avena sativa*) and barley (*Hordeum vulgare*) can be used as dual purpose *i.e.* these can be used as a source of grain as well as fodder. These crops have production potential to meet the requirements of human and livestock population. Therefore, as a dual purpose (green forage and feed/grain) crop, it provides welcome boost to the forage growers and fits well for crop diversification in the integrated crop livestock production system. Growth of plant is directly related to the nutrient supply and if it is in the integrated form, it adds more to growth. Hence, a judicious combination of

chemical fertilizers, organic manures and biofertilizers can be of vital importance in order to achieve optimum and economic yield of fodder oats. Integrated Nutrient Management directly enhances the nutrient uptake with better accumulation in grains (Devi *et al*., 2009) [2]. Balanced fertilizer use along with organic manure like farm yard manure (FYM) is considered as promising agro- technique to sustain yield, increase fertilizer-use efficiency and restore soil fertility (Verma *et al*., 2016) [8]. Nitrogen plays pivotal role in the quantitive as well as qualitative improvement in the productivity of fodder. It is an important constituent of protein and chlorophyll. It imparts dark green colour to the plants and promotes early vegetative growth (Patel *et al*., 2007) [6]. In order to determine the effects of nitrogen on the production potential of *rabi* cereal fodders, the experiment was initiated during *rabi* season, 2017-18 at Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu with an objective to determine the integrated effect of differential substitution of Farm Yard Manure on growth and growth attributes of dual purpose *rabi* fodders.

Materials and Methods

The experiment was carried out at Research Farm of Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main campus Chatha, during *rabi* season of the year 2017-18. Geographically, the experimental site is situated in the sub-tropical Shiwalik foothills of Jammu and Kashmir at 32º39′ N latitude and 74^{0}53′ E longitude at an elevation of 332 meter above mean sea level. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen but medium in available phosphorus and potassium with electrical conductivity in the safer range. The experimental site is endowed with hot and dry early summers followed by hot and humid summers and cold winters. The contribution of South-West monsoon rains which are usually received from June to September is about 75 per cent, whereas the remaining 25 per cent of rains are received in the form of few showers of cyclonic winter rains from December to March with mean annual rainfall of about 1174 mm. The experiment was laid out in Randomized Block Design with twelve treatments replicated thrice. The treatments comprised of three different dual purpose *rabi* fodders *viz*. oats, barley and wheat. Field experiment was conducted during *rabi* 2017-18. The experiment comprised of 12 treatments which were laid out in Randomized Block Design with 3 replications.

Results and Discussions

Plant height

Plant height is a reliable index of growth and development representing the vertical growth over a period of time. Perusal of the data revealed that among the different INM treatments, application of RDF +25% N through FYM recorded significantly highest plant height both at first cut and at final harvest in all the dual purpose *rabi* fodders under study. However, it was statistically at par with 75 % RDF + 50 % N through FYM whereas treatment 25 % RDF + 100 % N through FYM recorded lowest plant heights both at first cut and at harvest in all the different *rabi* fodder crops studied in the experiment. Among the different dual purpose *rabi* fodders, oats was found to be the most superior in attaining maximum plant height of 63.70 cm and 136.49 cm at first cut and at harvest (T_1), respectively. It was followed by wheat under treatment T_9, recording plant heights of 48.83 cm and 91.01 cm and barley under treatment T_5 recording plant heights of 40.47 cm and 74.43 cm at first cut and at final harvest, respectively. Whereas, the minimum plant height among the different fodder crops, both at first cut and at final harvest was recorded with the application of 25 % RDF + 100 % N through FYM, recording plant heights of 24.37 cm and 48.50 cm in barley under T_8, followed by wheat recording plant heights of 29.37 cm and 65.38 cm under treatment T_{12} followed by oats recording plant heights of 47.73 cm and 110.69 cm in treatment T_4 both at first cut and at final harvest, respectively.

Table 1: Effect of Integrated Nutrient Management on plant height (cm) of dual purpose *rabi* fodders

Treatments	At first cut	At final harvest
T_1 - Oats with recommended dose of fertilizers + 25 % N through FYM	63.70	136.49
T_2 - Oats with 75 % recommended dose of fertilizers + 50 % N through FYM	60.43	132.01
T_3 - Oats with 50 % recommended dose of fertilizers + 75 % N through FYM	54.57	123.39
T_4 - Oats with 25 % recommended dose of fertilizers + 100 % N through FYM	47.73	110.69
T_5 - Barley with recommended dose of fertilizers + 25 % N through FYM	40.47	74.43
T_6 - Barley with 75 % recommended dose of fertilizers + 50 % N through FYM	38.92	71.67
T_7 - Barley with 50 % recommended dose of fertilizers + 75 % N through FYM	31.60	60.53
T_8 - Barley with 25 % recommended dose of fertilizers + 100 % N through FYM	24.37	48.50
T_9 - Wheat with recommended dose of fertilizers + 25 % N through FYM	48.83	91.01
T_{10} - Wheat with 75 % recommended dose of fertilizers + 50 % N through FYM	45.27	87.17
T_{11} - Wheat with 50 % recommended dose of fertilizers + 75 % N through FYM	38.43	77.32
T_{12} - Wheat with 25 % recommended dose of fertilizers + 100 % N through FYM	29.37	65.38
Sem (±)	1.92	3.19
CD (5%)	5.66	9.38

Leaf area index (LAI)

Leaf area index has direct effect on growth and yield parameters of plant. It expresses the capacity of plants to trap solar energy for photosynthesis. Among the different treatments of INM, application of RDF + 25 % N through FYM recorded maximum leaf area index both at first cut and at final harvest in different dual purpose *rab*i fodders, which was statistically at par with the application of 75 % RDF + 50 % N through FYM whereas, the minimum LAI was observed with the application of 25 % RDF + 100 % N through FYM. Oats recorded maximum leaf area index of 4.82 and 3.10 at first cut and at final harvest under treatment T_1, followed by wheat (2.83 and 1.97) under T_9 and barley (2.63 and 1.92) in T_5. However, the minimum values of leaf area index in different dual purpose *rabi* fodders were recorded under the application of 25 % RDF + 100 % N through FYM in which barley recorded minimum leaf area index of 1.32 and 1.13 under treatment T_8 followed by wheat under T_{12} having LAI of 1.50 and 1.16 which was followed by oats recording LAI of 3.68 and 2.40 at first cut and at final harvest, respectively.

Table 2: Effect of Integrated Nutrient Management on leaf area index of dual purpose *rabi* fodders

Treatments	At first cut	At final harvest
T_1 - Oats with recommended dose of fertilizers + 25 % N through FYM	4.82	3.10
T_2 - Oats with 75 % recommended dose of fertilizers + 50 % N through FYM	4.69	2.97
T_3 - Oats with 50 % recommended dose of fertilizers + 75 % N through FYM	4.18	2.69
T_4 - Oats with 25 % recommended dose of fertilizers + 100 % N through FYM	3.68	2.40
T_5 - Barley with recommended dose of fertilizers + 25 % N through FYM	2.63	1.92
T_6 - Barley with 75 % recommended dose of fertilizers + 50 % N through FYM	2.49	1.71
T_7 - Barley with 50 % recommended dose of fertilizers + 75 % N through FYM	1.86	1.44
T_8 - Barley with 25 % recommended dose of fertilizers + 100 % N through FYM	1.32	1.13
T_9 - Wheat with recommended dose of fertilizers + 25 % N through FYM	2.83	1.97
T_{10} - Wheat with 75 % recommended dose of fertilizers + 50 % N through FYM	2.55	1.74
T_{11} - Wheat with 50 % recommended dose of fertilizers + 75 % N through FYM	2.02	1.47
T_{12} - Wheat with 25 % recommended dose of fertilizers + 100 % N through FYM	1.50	1.16
Sem (±)	0.16	0.08
CD (5%)	0.49	0.25

Fresh weight

Data pertaining to fresh weight recorded at first cut shows that the application of RDF + 25 % N through FYM recorded significantly highest fresh weight in all the dual purpose *rabi* fodders among all the treatments of INM. However, it was statistically at par with 75 % RDF + 50 % N through FYM while the minimum fresh weight was recorded with the application of 25 % RDF + 100 % N through FYM. Among the different dual purpose *rabi* fodders, oats recorded maximum fresh weight of 1.75 kg/m^2 under treatment T_1 followed by wheat and barley having fresh weights of 1.13 kg/m^2 under T_9 and 0.90 kg/m^2 in treatment T_5 at first harvest of fodder. While as the minimum fresh weight was obtained with the application of 25 % RDF + 100 % N through FYM at first cut in which barley recorded minimum fresh weight of 0.30 kg/m^2 under T_8 followed by wheat and oats recording fresh weights of 0.56 kg/m^2 and 1.04 kg/m^2 under treatments T_{12} and T_4, respectively.

Table 3: Effect of Integrated Nutrient Management on fresh and dry weight (kg/m^2) of dual purpose *rabi* fodders

Treatments	Fresh weight	Dry weight
T_1 - Oats with recommended dose of fertilizers + 25 % N through FYM	1.75	0.33
T_2 - Oats with 75 % recommended dose of fertilizers + 50 % N through FYM	1.63	0.31
T_3 - Oats with 50 % recommended dose of fertilizers + 75 % N through FYM	1.33	0.26
T_4 - Oats with 25 % recommended dose of fertilizers + 100 % N through FYM	1.04	0.21
T_5 - Barley with recommended dose of fertilizers + 25 % N through FYM	0.90	0.20
T_6 - Barley with 75 % recommended dose of fertilizers + 50 % N through FYM	0.80	0.16
T_7 - Barley with 50 % recommended dose of fertilizers + 75 % N through FYM	0.49	0.11
T_8 - Barley with 25 % recommended dose of fertilizers + 100 % N through FYM	0.30	0.13
T_9 - Wheat with recommended dose of fertilizers + 25 % N through FYM	1.13	0.22
T_{10} - Wheat with 75 % recommended dose of fertilizers + 50 % N through FYM	0.96	0.21
T_{11} - Wheat with 50 % recommended dose of fertilizers + 75 % N through FYM	0.77	0.18
T_{12} - Wheat with 25 % recommended dose of fertilizers + 100 % N through FYM	0.56	0.13
Sem (±)	0.06	0.01
CD (5%)	0.18	0.03

Dry weight

It is clear from table 4 that the dry weight was also significantly influenced with the application of INM treatments in a similar manner as observed for fresh weight. Likewise, under different treatments, significantly

maximum dry weight was recorded with the application of RDF + 25 % N through FYM in all the dual purpose *rabi* fodders. However, it was statistically at par with the application of 75 % RDF + 50 % N through FYM. While the minimum dry weight was recorded with the application of 25 % RDF + 100 % N through FYM. Among all the dual purpose *rabi* fodders, oats recorded maximum dry weight of 0.33 kg/m^2 (T_1) followed by wheat 0.22 kg/m^2 (T_9) and barley 0.20 kg/m^2 (T_5). However, the minimum dry weight was recorded with the application of 25 % RDF + 100 % N through FYM among different dual purpose *rabi* fodders under study where in barley recorded minimum dry weight (0.13 kg/m^2) under T_8 followed by wheat and oats under treatment T_{12} (0.18 kg/m^2) and treatment T_4 (0.21 kg/m^2), respectively.

Number of plants/m running row length

It is clearly depicted in Table 5 that among the different INM treatments of different dual purpose *rabi* fodders, application of RDF + 25 % N through FYM recorded highest number of plants/m running row length, both at first cut and at final harvest, which was statistically at par with the application of 75 % RDF + 50 % N through FYM. Whereas, significantly lowest number of plants/m running row length were recorded with application of 25 % RDF + 100 % N through FYM. Among different dual purpose *rabi* fodders, significantly highest number of plants/m running row length were recorded in oats followed by wheat and barley. Significantly highest number of plants/m running row length were recorded in oats under treatment T_1 to the tune of 70 and 60.93 at first cut and at final harvest followed by wheat under treatment T_9 recording number of plants/m to the tune of 63.33 at first cut and 55.33 at final harvest, which was again followed by barley under treatment T_5 recording 59.65 and 50.80 plants/m at first cut and at final harvest, respectively. Among the different dual purpose *rabi* fodders under study, oats was found to be the most superior in attaining maximum number of plants/m^2 (354.98 and 304.67) under treatment T_1 followed by wheat (316.67 and 276.67) in T_9 and barley (310.67 and 266.04) in T_5 both at first cut and final harvest, respectively (Table 12, Fig. 4). Whereas the minimum number of plants/m^2 were recorded under the application of 25 % RDF + 100 % N through FYM in which barley recorded minimum number of plants/m^2 (216.28 and 198.33 at first cut and at final harvest) under T_8 followed by wheat (235.63 and 206.17) under T_{12} which was again followed by oats under treatment T_4 having 269.85 and 231.50 plants/m^2 at first cut and at final harvest, respectively.

Table 4: Effect of Integrated Nutrient Management on number of plants/m running row length of dual purpose *rabi* fodders

Treatments	At first cut	At final harvest
T_1 - Oats with recommended dose of fertilizers + 25 % N through FYM	71.00	60.93
T_2 - Oats with 75 % recommended dose of fertilizers + 50 % N through FYM	68.67	58.67
T_3 - Oats with 50 % recommended dose of fertilizers + 75 % N through FYM	61.33	52.36
T_4 - Oats with 25 % recommended dose of fertilizers + 100 % N through FYM	53.97	46.30
T_5 - Barley with recommended dose of fertilizers + 25 % N through FYM	62.13	53.21
T_6 - Barley with 75 % recommended dose of fertilizers + 50 % N through FYM	59.65	50.80
T_7 - Barley with 50 % recommended dose of fertilizers + 75 % N through FYM	50.67	45.23
T_8 - Barley with 25 % recommended dose of fertilizers + 100 % N through FYM	43.26	39.67
T_9 - Wheat with recommended dose of fertilizers + 25 % N through FYM	63.33	55.33
T_{10} - Wheat with 75 % recommended dose of fertilizers + 50 % N through FYM	61.67	52.67
T_{11} - Wheat with 50 % recommended dose of fertilizers + 75 % N through FYM	54.48	46.93
T_{12} - Wheat with 25 % recommended dose of fertilizers + 100 % N through FYM	47.13	41.23
Sem (±)	7.13	5.51
CD (5%)	2.43	1.87

Forage yield

The scrutiny of the data presented in the Table 6 regarding the forage yield revealed that among the different INM treatments, significantly maximum forage yield was recorded with the application of RDF + 25 % N through FYM in different dual purpose *rabi* fodders which was statistically at par with 75% RDF + 50% N through FYM. Whereas the minimum forage yield was obtained under the application of 25 % RDF + 100 % N through FYM among different combinations of nutrient management treatments. Among the different dual purpose *rabi* fodders, oats was found to be most superior in attaining maximum forage yield (193.94 q/ha) under treatment T_1 followed by wheat (100.79 q/ha) under T_{12} and barley (85.48 q/ha) under treatment T_5. However, the minimum forage yield was recorded under the application of 25 % RDF + 100 % N through FYM in which barley recorded forage yield of 48.51 q/ha under T_8 followed by wheat 65.21 q/ha under treatment T_{12} and oats 139.15 q/ha in treatment T_4 among different INM treatments.

Table 5: Effect of Integrated Nutrient Management on forage yield (q/ha) of dual purpose *rabi* fodders

Treatments	Forage Yield (q/ha)
T_1 - Oats with recommended dose of fertilizers + 25 % N through FYM	193.94
T_2 - Oats with 75 % recommended dose of fertilizers + 50 % N through FYM	181.14
T_3 - Oats with 50 % recommended dose of fertilizers + 75 % N through FYM	162.64
T_4 - Oats with 25 % recommended dose of fertilizers + 100 % N through FYM	139.15
T_5 - Barley with recommended dose of fertilizers + 25 % N through FYM	85.48
T_6 - Barley with 75 % recommended dose of fertilizers + 50 % N through FYM	79.19
T_7 - Barley with 50 % recommended dose of fertilizers + 75 % N through FYM	63.83
T_8 - Barley with 25 % recommended dose of fertilizers + 100 % N through FYM	48.51
T_9 - Wheat with recommended dose of fertilizers + 25 % N through FYM	100.79
T_{10} - Wheat with 75 % recommended dose of fertilizers + 50 % N through FYM	96.92
T_{11} - Wheat with 50 % recommended dose of fertilizers + 75 % N through FYM	81.50
T_{12} - Wheat with 25 % recommended dose of fertilizers + 100 % N through FYM	65.21
Sem (±)	5.17
CD (5%)	15.18

Summary and conclusion

From the above mentioned study, it can be concluded that the recommended dose of fertilizers along with 25% addition proved o be the best treatment with reference to the growth and growth parameters in dual purpose *rabi* fodders.

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