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Quality assessment of berseem genotypes under different row spacings and fertilizer levels

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Abstract
An experiment was conducted at the fodder Scheme, UAS, Dharwad during *rabi* seasons of 2020-21 and 2021-22 to study the fodder quality of berseem genotypes as influenced by row spacing and fertilizer levels. The treatments consisted combinations of three genotypes (Vardhan, BB 2 and BB 3), two row spacings (30 and 45 cm) and three RDF levels (75%, 100% and 125% RDF levels). Among the various proximate analysis, pooled results indicated that higher values of ash content, CP with lower CF and OM content were recorded with genotype BB 2 compared to BB3 and Vardhan. Application of 125% RDF produced higher values of ash content, CP with lower CF content and OM content over 100% and 75% RDF. This might be due to increased uptake of minerals from soil under higher fertility levels and better partitioning of available resources. Among the row spacings, the berseem sown at 45 cm rows recorded maximum ash content, CP with lower CF content and OM content compared to 30 cm. It could be concluded, that the interaction effect of combination of BB 2 along with 125% RDF at 45 cm row spacing resulted in higher green and dry fodder yields with superior quality fodder for better nutritional security during *rabi* season.

Keywords: Ash, berseem, crude fibre, crude protein, genotypes, RDF levels, row spacings, organic matter

Introduction
Berseem (*Trifolium alexandrinum*) is the prominent legume fodder crop of *rabi* in the entire North West, Zone, Hill Zone and part of Central and Eastern Zone of the country occupying an area of 2 million hectares. Berseem makes the most digestible and palatable green fodder to the cattle and especially milch animals are very much benefited with berseem. It provides fodder with high tonnage over a long period from November to May in 5 – 6 cuts. Not only this it is capable of fixing 100–200 kg of nitrogen/ ha per year (Daneshnia *et al*., 2015) [4]. It has 20-24% crude protein and 70% dry matter digestibility, its invariably rich in protein, ether extract, crude fibre, ash content, nitrogen free extract, calcium and phosphorus.
Fodder quality is of great importance as well as higher fodder yield for both food and nutritional security. The fodder quality of berseem depends on many factors such as fertilization, irrigation, genotype, plant density and harvesting time. Maturity stage at harvest is the most important factor determining fodder quality and it decreases with advancing maturity. Also, the maturity of fodder crops influence fodder digestibility and consumption by animals (Ball *et al.*, 2001) [2].
Generally, coming to fertilization most of the fodder growers rely only on nitrogenous fertilizers without bothering for balanced plant nutrition. Very less amount of work has been done on the response of fertilizers and the farmers do not have a tendency to invest on fertilizers for fodder crops (Malakar *et al*. 2009) [14]. Presently, the fodder crops are cultivated on poor, problematic soils, marginal lands with low fertility or on the bunds of the farm. Hardly any studies have shown or optimized the standardized the appropriate quantities of application of fertilizers for different genotypes. Thus, in order to augment green fodder production to its economic potential through improved cultivars, scientific fodder management, fodder and fodder production as mixed crop or intercrop with scientific production technologies in order to supply the deficit green fodder and quality fodder to maintain livestock's health and productivity is much needed.
In Karnataka, the area under fodder during *rabi*/winter season crops is rather less. Among the winter forages, only few perennial fodder crops are potential yielders with excellent quality. The grasses are shy yielders during winter season due to cold weather conditions. Hence, their productivity and quality is less to meet the growing demand of green fodder for livestock.

Therefore, cultivation of prolific fodder yielders with superior quality is need of the hour for continuous production of *rabi* fodder during the cold conditions. Apart from this, research information on winter forages is quite meagre. Based on this different agrotechniques such as genotypes, spacing, fertilizer levels *etc.* was planned to optimize to obtain better productivity and quality of fodder crops.

Material and Methods

The field experiment was conducted in fodder Scheme, Main Agriculture Research Station (MARS), University of Agricultural Sciences, Dharwad (Karnataka) during *rabi* seasons of 2020-21 and 2021-22. The soil of experimental site was red sandy loam with neutral in pH (7.73), organic carbon (0.48%), available N (217.9 kg ha^{-1}), P_2O_5 (24.8 kg ha^{-1}) and K_2O (298.6 kg ha^{-1}) content. The experiment was laid out in split split plot design with three replications. The experiment consists of three genotypes (Vardhan, BB 2 and BB 3) in main plots, two row spacings (30 and 45 cm) in sub plots and three RDF levels (75%, 100% and 125% RDF levels) in sub-sub plots. The experimental plot was prepared well to bring the soil to fine tilth. Then the farm yard manure was evenly spread @ 12.5 t ha^{-1} on the field and plots of 4 m x 3.6 m were made. Berseem genotypes were sown using a seed rate of 15 kg ha^{-1} and recommended dose of fertilizer (RDF) at 25:80: 30 kg N: P_2O5: K_2O ha^{-1} were applied as per the treatment schedule. The fertilizer dose was split and applied after harvesting of each cut. The other package of practices were adopted to raise the crops. The crop was sown on 11th November 2020 and harvested on 3rd March 2021, during first year. Whereas during second year, crop was sown on 26th October 2021 and harvested on 23rd February 2022. The total rainfall during the cropping period was 1108.6 mm and 878.5 mm during 2020 and 2021, respectively. Irrigation was given at weekly interval. Plant sampling was done in net plot area at harvest and the quality attributes of fodder were estimated using Van soest method (1991). The harvesting was done from net plot and the yield was expressed in tonnes per hectare.

The experimental data recorded on yield and quality attributes were analysed statistically using MS Excel by Analysis of Variance (ANOVA) suggested by (Gomez and Gomez, 1984). The treatment difference were calibrated using Duncan multiple range test (DMRT) using SPSS (ver. 20) software.

Results and Discussion

The yield and quality parameters differed significantly due to berseem genotypes, row spacings and RDF levels.

Performance of berseem genotypes

The pooled results of two years (Table 1) indicated that genotype BB 2 produced significantly higher green (59.83 t ha^{-1}) and dry fodder yield (16.98 t ha^{-1}) compared to BB3 (58.09 and 15.52 t ha^{-1}, respectively) and Vardhan and (44.04 and 8.93 t ha^{-1}, respectively). The difference in yields between the genotypes might due to genetic potential and morphological characteristic of varieties in exploiting climatic optima at important crop growth stages. These results were in agreement with the findings of Kaur *et al.* (2013) [12] who reported that in PL 172 variety of fodder barley gave significantly higher yield of dry fodder PL 426 and RD 2552 which was due to higher yield potential.

Among the genotypes, BB 2 (G_2) recorded maximum crude protein content (19.42%), Ash (13.7%) and crude fibre content (20.87%), organic matter content (86.41%) over BB 3 and Vardhan which was due to higher yield potential of the genotype. Similar findings of the experiment conducted by Chaturvedi *et al.* (2020) [3] indicated that variety JHO-99-2 recorded significantly higher crude protein, ash, ether extract and nitrogen free extract with low crude fibre content compared to other varieties.

Effect of spacing on yield and quality of berseem genotypes

Between row spacings, sowing at 45 cm recorded significantly higher green and dry fodder yield (57.94 and 15.73 t ha^{-1} respectively) over that of 30 cm row spacing (50.04 and 11.90 t ha^{-1} respectively) as represented in table 1. The higher yield at 45 cm row spacing was mainly due to ample availability of space, moisture, solar radiation, efficient utilization of resources and nutrients. Compared to closer row spacing higher green and dry are resultant of higher growth parameters obtained throughout the crop period. The higher yield may be due to competition free environment under wider spacing. These results were in agreement with the findings of Manjunatha *et al*. (2014) [15] green fodder and dry matter yield was higher with a row spacing of 45 cm and 60 cm compared to that of 30 cm.

Maximum ash content (13.53%), crude protein (19.31%) with lower crude fibre content (20.89%) and Organic matter content (86.47%) was noticed in a row spacing of 45 cm compared to 30 cm. This is due to higher yields that has resulted due to wider spacing. These results were in accordance with findings of experiment conducted by Manjunatha *et al*. (2014) [15] where higher crude protein, crude fibre, and ether extract was achieved with the adoption of wider spacing 60 cm × 50 cm compared to 30 cm row spacing.

Effect of fertilizer levels on yield and quality of berseem genotypes

Among RDF levels, (Table 1) application of 125% RDF recorded significantly higher green and dry fodder yield (59.01 and 16.56 t ha^{-1}, respectively) as compared to 100% (53.61 and 13.78 t ha^{-1}), respectively and 75% RDF (49.35 and 11.10 t ha^{-1}), respectively. The higher fertility levels accelerated the process of cell division, enlargement and stem elongation leading to luxuriant growth and higher yield. These findings were in conformity with the findings Karwasra *et al.* (1998) [9] who observed that application of 100 per cent recommended dose of nitrogen (60 kg ha^{-1}) produced significantly higher green fodder yield (513.2 q ha^{-1}) and dry matter yield (90.2 q ha^{-1}) of barley when compared to other levels of nitrogen. The bioavailability and concentration of fodder minerals varies greatly depending on fertilizer application. Nitrogen application management and appropriate cultivar appears to be important parameters for obtaining high fodder quality yields and high nutritive value of berseem clover in semi-arid regions.

Higher values of ash content (13.56%), crude protein (19.34%) with lower crude fibre content (20.84%) and Organic matter content (86.44%) were produced with the application of 125% RDF to berseem over 100% and 75% RDF among the fertilizer levels. These findings were in affirmation with Yadav *et al.* (2003) who reported that the improvement in protein under the influence of additional N and P fertilization seems to be on account of increased N content and decrease in crude fibre content might be due to synthesis of more structural carbohydrates at later stages. The crude fibre content decreased significantly with increase in nitrogen levels. This could be attributed to increase in crude protein content due to higher nitrogen fertilization as reported by Manjunath *et al*. (2014) [15] in fodder sorghum.

Interaction effect on yield and quality of berseem

Interaction effects indicated that genotype, BB 2 sown at 45 cm rows with 125% RDF ($G_2S_2F_3$) produced significantly higher green (66.11 t ha^{-1}) and dry fodder yields (21.27 t ha^{-1}) as compared to rest of the treatment combinations except genotype BB 3 sown at 45 cm rows with 125% RDF ($G_3S_2F_3$) with which it was on par (Table 1). This can be attributed to their genetic potentiality to utilize and translocate photosynthates from source and sink. Combination of 45 cm row spacing along with 300 kg N ha^{-1} recorded the higher total green fodder (187.5 t ha^{-1}) and total dry matter yield as reported by Manjunatha *et al*. (2014) [15] in fodder sorghum.

Significantly higher values of crude protein (19.88%), ash content (14.15%) with decreased crude fibre content (20.14%) and organic matter content (85.85%) were found in the combined effect of BB 2 along with 125% RDF at 45 cm row spacing. Higher protein and ash content might be due to better yields and dry matter produced in response of cultivar under wider spacing and increased doses of fertilization. The maximum ash percentage was related to interaction between application of 40 kg N/ha and Sacromont cultivar of berseem clover which was similar to our findings (Soleymani *et al*. 2011) [17].

Table 1: Yield and quality of berseem genotypes as influenced by row spacing and fertilizer levels

Treatments	Green fodder yield (t ha^{-1})	Dry fodder yield (t ha^{-1})	Ash content (%)	Crude protein content (%)	Crude fibre content (%)	Organic matter content (%)
Genotypes (G)						
G_1: Vardhan	44.04c	8.93c	12.74^{b}	18.72b	21.42a	87.26a
G_2: BB 2	59.83a	16.98a	13.7^{a}	19.42a	20.83b	86.30b
G_3: BB 3	58.09b	15.52b	13.59^{ab}	19.33ab	20.87b	86.41b
S. E. m±	0.36	0.10	0.09	0.13	0.15	0.62
Row spacing (S)						
S_1: 30 cm	50.04b	11.90a	13.16b	19.00b	21.19a	86.84a
S_2: 45 cm	57.94a	15.73a	13.53a	19.31a	20.89b	86.47b
S. E. m±	0.38	0.10	0.10	0.15	0.16	0.66
RDF levels (F)						
F_1: 75% RDF	49.35c	11.10c	13.14b	18.97	21.28a	86.86a
F_2: 100% RDF	53.61b	13.78b	13.34b	19.15b	21.00ab	86.66a
F_3: 125% RDF	59.01a	16.56a	13.56a	19.34a	20.84b	86.44a
S. E. m±	0.93	0.25	0.22	0.32	0.35	1.43
Interaction (G X S X F)						
$G_1S_1F_1$	40.78^{j}	6.39^{k}	12.53^{a}	18.59^{a}	21.48^{a}	87.47^{a}
$G_1S_1F_2$	41.84^{ij}	7.97^{jk}	12.6^{a}	18.63^{a}	21.46^{a}	87.4^{a}
$G_1S_1F_3$	43.49^{hij}	9.5^{ij}	12.76^{a}	18.7^{a}	21.42^{a}	87.24^{a}
$G_1S_2F_1$	42.36^{ij}	9.03^{ij}	12.7^{a}	18.68^{a}	21.44^{a}	87.30^{a}
$G_1S_2F_2$	47.67^{ghij}	10.19^{hi}	12.89^{a}	18.8^{a}	21.36^{a}	87.11^{a}
$G_1S_2F_3$	48.09^{ghij}	10.5^{hi}	12.97^{a}	18.89^{a}	21.32^{a}	87.03^{a}
$G_2S_1F_1$	50.77^{gh}	11.82^{fgh}	13.2^{a}	19.00^{a}	21.15^{a}	86.80^{a}
$G_2S_1F_2$	52.42^{efg}	13.23^{ef}	13.46^{a}	19.18^{a}	21.13^{a}	86.54^{a}
$G_2 S_1F_3$	61.11^{cd}	17.56^{cd}	13.81^{a}	19.49^{a}	20.93^{a}	86.19^{a}
$G_2S_2F_1$	58.19^{cdef}	14.77^{e}	13.70^{a}	19.34^{a}	21.11^{a}	86.3^{a}
$G_2S_2F_2$	64.22^{bc}	19.78^{b}	13.91^{a}	19.64^{a}	20.5^{a}	86.09^{a}
$G_2S_2F_3$	72.29^{a}	24.74^{a}	14.15^{a}	19.88^{a}	20.14^{a}	85.85^{a}
$G_3S_1F_1$	48.94^{ghi}	11^{ghi}	13.11^{a}	18.95^{a}	21.18^{a}	86.9^{a}
$G_3S_1F_2$	51.64^{fg}	12.66^{fg}	13.31^{a}	19.11^{a}	20.89^{a}	86.69^{a}
$G_3S_1F_3$	59.36^{cde}	16.92^{d}	13.66^{a}	19.38^{a}	21.05^{a}	86.34^{a}
$G_3S_2F_1$	55.06^{defg}	13.56^{ef}	13.61^{a}	19.24^{a}	21.30^{a}	86.39^{a}
$G_3S_2F_2$	63.84^{bc}	18.86^{bc}	13.88^{a}	19.56^{a}	20.64^{a}	86.12^{a}
$G_3S_2F_3$	69.7^{ab}	20.11^{b}	13.98^{a}	19.72^{a}	20.16^{a}	86.02^{a}
S.Em.±	2.27	0.62	0.54	0.78	0.85	3.50

Note: RDF: 25: 80:30 kg N, P_2O_5 and K_2O

Table 2: Correlation matrix indicating the association between green and dry fodder yield with quality of berseem

Treatments	Green fodder yield (t ha^{-1})	Dry fodder yield (t ha^{-1})	Ash content (%)	Crude protein content (%)	Crude fibre content (%)	Organic matter content (%)
Green fodder yield (t ha^{-1})	1					
Dry fodder yield (t ha^{-1})	0.99	1				
Ash content (%)	0.97	0.96	1			
Crude protein content (%)	0.99	0.98	0.99	1		
Crude fibre content (%)	-0.93	-0.93	-0.86	-0.91	1	
Organic matter content (%)	-0.97	-0.96	-1.00	-0.99	0.86	1

Correlation

The green fodder yield showed a positive correlation with the quality parameters such as dry fodder yield, crude protein content and ash content whereas negative correlation was observed with that of crude fibre and organic matter content of the fodder (Table 2.).

Conclusion

Based on the pooled results, it can be concluded that application of 125% RDF to berseem genotype, BB2 sown at 45 cm row spacing were found optimum to obtain higher green and dry fodder yields in Northern Transition Zone of Karnataka, India for better nutritional security during *rabi* season.

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