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EFFECT OF VARYING LEVELS AND FREQUENCY OF MAGNESIUM FERTILIZATION ON YIELD AND NUTRIENT UPTAKE OF BAJRA NAPIER HYBRID

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SUMMARY

A field experiment was conducted at AICRP on Forage Crops and Utilization, College of Agriculture, Vellayani, Thiruvanathapuram, Kerala during October 2020 to April 2021 to study the influence of variation in levels and frequency of magnesium fertilization on yield and nutrient uptake of Bajra Napier hybrid. The experiment was laid out in factorial RBD with nine treatments replicated thrice. The treatment combinations included three levels of magnesium [M_1- 80 kg/ha, M_2 - 100 kg/ha and M_3 - 120 kg/ha] and three frequency of application [F_1- split application once in 3 months, F_2- split application once in 4 months and F_3- split application once in 6 months]. Results of the study revealed that during the study period highest mean green and dry fodder yield and N and P uptake was recorded with split application of 100 kg $MgSO_4$/ha given once in 6 months. However significantly higher potassium uptake was recorded with split application of 80 kg $MgSO_4$/ha once in 6 months. The magnesium level of 100 kg $MgSO_4$/ha given once in 3 months recorded the highest Mg uptake.

Key words : Bajra Napier hybrid, dry fodder yield, green fodder yield, magnesium fertilization, nutrient uptake

Bajra Napier hybrid is a tufted perennial humid tropical grass and is popular among dairy farmers of Kerala due to its robust growth, higher productivity, quality, palatability, and persistence. The crop is known for its high growth rate and quick regeneration capacity with profound response to added fertilizers, providing assured supply of quality fodder year round.The imbalanced application of primary nutrients over prolonged periods resulted in deficiency of secondary minerals such as magnesium and calcium which thereby affected the productivity as well as quality of forage. Lack of magnesium (Mg) is common in Kerala with its acid soils, heavy fertilization with major nutrients, and leaching under heavy rainfall. Also our soils lack behind in magnesium reserves. Nearly 70 per cent of Kerala soils are deficient in magnesium(GOK, 2018). Magnesium often considered as a forgotten element, its nutrition in plants is seldom addressed and deficiencies will adversely affect productivity and quality in agriculture (Aitken *et al*., 1999). Magnesium being the central atom in chlorophyll molecule, is vital for various physiological and biochemical processes in plants including photosynthesis, protein synthesis, root formation, nucleotide metabolism and a much more. In the light of the above facts, a study was undertaken to assess the effect of varying levels and frequency of application of magnesium on yield and nutrient uptake in Bajra Napier hybrid.

MATERIALS AND METHODS

The experiment was laid out in the upland area of the Instructional Farm attached to the College of Agriculture, Vellayani, Thiruvananthapuram, Kerala, geographically located at 80 25' 46" North latitude and 760 59' 24" E longitude, at an altitude of 30 m above the mean sea level. The soil in the experimental site was identified as sandy clay loam in texture, moderately acidic (pH 5.75) in reaction, medium in organic carbon (0.90%), available nitrogen (398.55 kg/ha) and available potassium (202.11 kg/ha), high in available phosphorus (38.86 kg/ha) and deficient in available calcium (259.13 mg/kg) and magnesium (20.67 mg/kg) status. The crop was planted during October 2020 and was maintained for six months for the study. Bajra Napier hybrid variety, Suguna, developed by crossing Composite 9 and FD 431, released from Kerala Agricultural University was used for the study. Three nodded stem cuttings of Bajra

Napier hybrid were used for planting. The crop was raised as per the POP recommendations of KAU comprising 25 t/ha FYM and 200:50:50 kg/ha NPK (KAU, 2016). Entire dose of phosphorus and potassium were applied as basal. Nitrogen was applied in equal split doses after every harvest. As the treatment comprised of different levels and split application of magnesium fertilizer, required amounts were calculated and applied to respective plots as per the experimental design. A total of three harvests were taken during the study period. The crop samples collected from each net plot were sun dried and then oven dried to a constant weight at 65 ± 5 ^{0}C for nutrient uptake studies. The dry matter content wascomputed and dry fodder yield was worked out and expressed in t/ha. Modified microkjeldhal method was used to estimate the nitrogen content in plant samples.Phosphorus content of diacid extract of plant samples were determined calorimetrically by Vanadomolybdo phosphoric yellow colour method using spectrophotometer. Flame photometry method was used for determining the potassium content in plants.The total magnesium content was determined by di-acid digestion and estimated using Atomic Absorption Spectrometry (Jackson, 1973). Nutrientuptake by the plant was calculated as the product of the nutrient content in plants and the dry weight of plant and expressed as kg/ha.

TABLE 1
Effect of magnesium levels and frequency of application on N, P, K and Mg uptake of Bajra Napier hybrid, kg/ha

Treatments	N uptake	P uptake	K uptake	Mg uptake
Magnesium levels (M)				
M_1	396.46	42.42	398.89	132.90
M_2	454.13	48.65	345.40	189.59
M_3	378.58	40.76	311.45	170.64
SEm (±)	4.54	0.38	3.95	1.93
CD (0.05)	13.598	1.13	11.853	5.799
Frequency of application (F)				
F_1	394.78	42.90	330.59	171.35
F_2	401.93	44.43	356.88	165.61
F_3	432.46	45.51	368.28	156.18
SEm(±)	4.54	0.38	3.95	1.93
CD (0.05)	13.598	1.13	11.853	5.799
Magnesium levels (M) x Frequency of application (F)				
M_1F_1	365.57	40.08	362.45	137.10
M_1F_2	382.63	41.43	413.14	132.06
M_1F_3	441.19	45.75	421.10	129.54
M_2F_1	461.26	50.03	326.16	201.84
M_2F_2	420.98	45.37	340.29	176.56
M_2F_3	480.16	50.57	369.74	190.38
M_3F_1	357.51	38.58	303.15	175.09
M_3F_2	402.18	43.48	317.21	188.21
M_3F_3	376.04	40.23	313.99	148.63
SEm (±)	7.86	0.65	6.85	3.35
CD (0.05)	23.552	1.958	20.531	10.045

M_1-80 kg/ha F_1-4 (split application once in 3 months)
M_2-100 kg/ha F_2-3 (split application once in 4 months)
M_3-120 kg/ha F_3-2 (split application once in 6 months)

RESULTS AND DICUSSSION

Fodder yield

The data pertaining to the green and dry fodder yield of Bajra Napier hybrid as influenced by varying levels and frequency of application of $MgSO_4$ and their interaction are presented in Table 2. The data revealed that varying doses and frequency of application of $MgSO_4$ and their interaction had significant influence on the fodder yield.

Application of 100 kg $MgSO_4$/ha recorded significantly higher green fodder yield in first (50.21 t/ha) and second harvest (50.23 t/ha). However in third cut, application of 120 kg $MgSO_4$/ha produced the highest green fodder yield (44.19 t/ha) and was statistically on par with application of 100 kg $MgSO_4$/ ha (Fig. 5). During all the three harvests, highest dry fodder yield of 12.73, 14.27 and 12.49 t/ha, respectively were recorded with application of 100 kg $MgSO_4$/ha and was significantly superior to other treatments. Profound influence of higher levels of $MgSO_4$ application on yield may be attributed to the crucial role magnesium plays in photosynthesis, as a phosphorus carrier, sugar synthesis, enhancement in nutrient uptake and starch translocation. Moreover magnesium being a major constituent of chlorophyll molecule, is actively involved in rapid plant growth, cell division and plays a significant role in plant metabolic activities which would have resulted in higher green fodder yield in Bajra Napier hybrid (Thampi, 2017). Similar result was obtained by Hao and Papadopoulos (2003) in cherry tomato.

Among the varying frequency of $MgSO_4$ application, split application once in 6 months recorded the highest green fodder yield during the first and second harvests. However during first cut it was statistically on par with split application once in 4 months. In the third harvest split application once in 6 months recorded significantly higher green fodder yield. Split application of fertilizer resulted in increase in accumulated herbage biomass and also allowed for much greater distribution of herbage mass accumulation over the growth period (Loaiza*et al*., 2019).

TABLE 2
Effect of magnesium levels and frequency of application on green fodder yield of Bajra Napier hybrid, t/ha

Treatments	Green fodder yield			Dry fodder yield		
	I cut	II cut	III cut	I cut	II cut	III cut
Magnesium levels (M)						
M_1	44.26	44.12	42.11	11.97	12.39	10.69
M_2	50.21	50.23	43.91	12.73	14.27	12.49
M_3	44.08	44.43	44.19	11.48	11.87	10.47
SEm (±)	0.70	0.56	0.50	0.18	0.30	0.22
CD (0.05)	2.106	1.679	1.486	0.528	0.884	0.67
Frequency of application (F)						
F_1	44.60	44.27	41.94	11.57	12.30	11.46
F_2	46.20	45.46	45.49	12.20	12.78	10.92
F_3	47.76	49.05	42.78	12.43	13.45	11.26
SE (±)	0.70	0.56	0.50	0.18	0.30	0.22
CD (0.05)	2.106	1.679	1.486	0.528	0.884	NS
Magnesium levels (M) x Frequency of application (F)						
M_1F_1	43.06	42.10	39.33	11.50	11.64	10.26
M_1F_2	44.30	43.63	42.67	12.15	12.24	10.36
M_1F_3	45.44	46.63	44.33	12.27	13.30	11.44
M_2F_1	48.62	48.89	44.37	12.51	14.22	14.04
M_2F_2	47.60	46.59	43.54	12.22	13.25	11.30
M_2F_3	54.40	55.19	43.83	13.47	15.34	12.15
M_3F_1	42.12	41.81	42.13	10.69	11.05	10.09
M_3F_2	46.69	46.15	50.26	12.22	12.85	11.11
M_3F_3	43.43	45.34	40.19	11.54	11.71	10.19
SEm (±)	1.22	0.97	0.86	0.31	0.51	0.39
CD (0.05)	3.647	2.908	2.574	0.914	1.531	1.16

M_1-80 kg/ha F_1-4 (split application once in 3 months)
M_2-100 kg/ha F_2-3 (split application once in 4 months)
M_3-120 kg/ha F_3-2 (split application once in 6 months)

Highest dry fodder yield was obtained with split application once in 6 months and was statistically on par with split application once in 4 months during the first and second harvests. However, in the third harvest varying frequency of magnesium application failed to elicit any significant difference in dry fodder yield of Bajra Napier hybrid. Split fertilizer application have been reported to produce maximum dry biomass than the crops subjected to single fertilizer treatment (Kartika *et al*., 2018). This might be due to the reduced potential loss of fertilizer material in split fertilizer application. The probability of nutrient loss from rhizosphere was highest in the case of single fertilizer application as the quantity of available fertilizer may be greater than the absorbing capacity of the crop roots.

The M x F interaction effect on green and dry fodder yield was found to be significant in all the three harvests. Split application of 100 kg $ha^{-1}MgSO_4$ givenonce in 6 months recorded the significantly higher green fodder yield in first and second harvests. During the third harvest 120 kg/ha $MgSO_4$ given as split application once in 4 months resulted in significantly higher green fodder yield.

The highest dry fodder yield was obtained with 100 kg/ha $MgSO_4$ given as split application once in 6 months in first and second harvests. However in the second cut it was statistically comparable with 100 kg/ha $MgSO_4$ given as split application once in 3 months. During the third cut, 100 kg/ha $MgSO_4$ given as split application once in 3 months recorded significantly higher dry fodder yield.

Nutrient uptake

The results on the effect of magnesium levels and frequency of application on the nutrient uptake of Bajra Napier hybrid are presented in Table 1. The results revealed that the variation in levels of magnesium fertilization and frequency of application had significant effect on N, P, K and Mg uptake by the crop.

Among the levels of magnesium fertilization, application of 100 kg $MgSO_4$/ha resulted in significantly higher N (454.13 kg/ha), P (48.65 kg/ha) and Mg uptake (189.59 kg/ha). The result is in agreement with the observations of Thampi (2017) who reported that application of 100 kg $MgSO_4$/ha recorded the highest nitrogen and magnesium uptake and attributed it to the increased dry fodder yield in these treatments. Magnesium is reported to be having a synergistic effect on N assimilation since the enzyme involved in nitrate reduction and glutamine synthesis are highly sensitive to the concentration of Mg. In this way magnesium fertilization enhances the N uptake and recovery percentage in rice plant (Choudhury and Khanif, 2001). Application of magnesium fertilizers favourably influenced the nitrogen uptake and assimilation in rice plant (Ding *et al*., 2006). Application of higher levels of magnesium promotes nutrient uptake and thereby enhances the leaf growth rate, increasing the assimilate translocation to growing roots and subsequently their nutrient acquiring capacity (Cakmak and Kirkby, 2008). George (2018) attributed the higher P absorption and uptake in rice plants to the enhanced tiller count/ hill and dry matter production (DMP) resulting from external supply of optimum level of magnesium fertilizer.

Uptake of potassium in Bajra Napier hybrid was reduced significantly with the application of varying levels of magnesium fertilizer. Significantly higher potassium uptake (398.89 kg/ha) was recorded

with application of 80 kg $MgSO_4$/ha. K uptake was negatively influenced by magnesium fertilization which might be attributed to the antagonistic interaction between them in the soil. Ding *et al*. (2006) reported about the depressive effect Mg has on the uptake of K in rice plants.

Nutrient use efficiency of plants was enhanced with split application of nutrients (Sitthaphanit*et al*., 2010). Within the varying frequency of $MgSO_4$ application, split application once in 6 months recorded significantly higher nitrogen (432.46 kg/ha) and phosphorus uptake (45.51 kg/ha). In the case of potassium (368.28 kg/ha), it was statistically on par with split application once in 4 months. Highest magnesium uptake (171.35 kg/ha) was observed with split application once in 3 months and the results were statistically comparable with split application once in 4 months. Magnesium with its unique physiochemical properties is loosely bound with negatively charged soil aggregates and hence may get readily replaced due to other cations and subsequently leach out of the soil and hence external supply of Mg fertilizer in split doses is essential for better magnesium uptake by crop plants.

Among the interactions 100 kg/ha $MgSO_4$ given as split application once in 6 months recorded highest nitrogen (480.16 kg/ha) and phosphorus uptake (50.57 kg/ha) and results were statistically on par with 100 kg/ha $MgSO_4$ given as split application once in 3 months. However, uptake of potassium (421.10 kg/ha) was found to be higher when 80 kg/ha $MgSO_4$ was given as split application once in 6 months and the results were comparable with 80 kg/ha $MgSO_4$ given as split application once in 4 months. Significantly higher magnesium uptake (201.84 kg/ha) was observed with split application of 100 kg/ha $MgSO_4$ given once in 3 months. External supply of magnesium fertilizer in split doses enhanced the uptake of Mg by the grass, since $MgSO_4$ release its constituents quickly, with the remainder in the soil being leached out due to natural dilution process and translocation of nutrients to the root system (Bamikole *et al*., 1998).

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