The Pharma Innovation Journal 2022; 11(12): 4819-4826

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 4819-4826

www.thepharmajournal.com
Received: 15-10-2022
Accepted: 22-11-2022

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Effect of growing environment and nitrogen levels on yield and quality of Bajra Napier Hybrid

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Abstract
An experiment was conducted in mango orchards of Agricultural Research Institute, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad between 2013 and 2017 to study the effect of shade and various levels of nitrogen fertilization on the yields, quality and anti-quality parameters of Bajra Napier Hybrid, a popular forage crop of the zone. Yield attributes *viz.*, L:S ratio and tillers per plant decreased by 8.64 and 13.7%, respectively when grown in shade, while N levels improved these attributes with increasing dosage significantly. The fodder yields were higher in sun than in shade, while the effect of nitrogen was significant up to 50% of recommended N. Dry matter percent was highest at state recommended N level while it reduced by 6.44% when grown under shade. The growing environment did not influence crude protein, but increased by increasing N positively. Crude fiber was however unaffected. The oxalate concentration was significantly higher under sun over that of shade grown crop with values of 1.85 and 1.77%, respectively; and increased with increasing nitrogen. Besides, shade increased nitrate concentration of crop significantly in each clipping. Nevertheless, the nitrate concentration was within the range prescribed for animal health while the magnitude of oxalates rarely reached the toxic range. Though the effect of growing environment seems insignificant on quality of BN hybrid during the period of study but continuous monitoring is inevitable owing to repercussions of climate change.

Keywords: Bajra Napier Hybrids, crude protein, forage yields, nitrates, oxalates

Introduction
Bajra Napier Hybrids (B x N hybrids) often referred to as BNHs are crosses between female parent bajra (*Pennisetum americanum* L.) and male parent napier grass (*Pennisetum purpureum* L). These interspecific hybrids are more vigorous than their parent species (Burton, 1944) [5] and have high biomass potential (Hanna *et al*., 2004) [12]. Being vegetative propagated these hybrids did not lose their vigor over years and are most accepted fodder crops all over the country and often referred to as 'King of Fodders' in southern part of the country. Many advantages of these hybrids over traditional forages like jowar, bajra and other grasses made them one of the most sought after fodders (Turano *et al.*, 2016; Singh *et al.*, 2019) [46, 36]. These hybrids are popularly grown as sole crops besides, intercrops in orchards (Senanayake, 1995; Subramanian *et al*., 2017; Nagaratna *et al*., 2019 and Haris, 2019) [33, 41, 23, 13].

The usual anti-nutrient factors associated with these hybrids are oxalate which are found to affect animal metabolism in different ways. Diet containing high soluble oxalates along with calcium or magnesium ions when fed to ruminants, bind together and become unavailable for assimilation in rumen (Talapatra *et al*., 1948; Watts, 1959; Gorb and Maksakow, 1962) [42, 50, 11], thus disturbing calcium and phosphate metabolism leading to excessive mobilization of bone minerals causing lameness in animals (McKenzia *et al*., 1988) [21]. However, when calcium is low in diet, oxalates are absorbed directly into blood from rumen. If the oxalate concentration is high in blood, it could combine with Ca^{2+} or Mg^{2+} in kidney during filtration process to form insoluble oxalate crystals often called kidney stones that might block the urine flow causing kidney failure (Lincoln and Black, 1980) [18]. Excessive consumption of oxalate-rich plants has long been a concern to animal nutrition and health (Rahman *et al*., 2017) [28]. Nitrates, on the contrary are anthropogenic anti-nutritional factors which tend to foray into foliage especially under injudicious use of nitrogenous fertilizers (Singh *et al*., 2000; Rahman *et al*., 2010; Kaur *et al*., 2016) [38, 29, 17]. Concerns raised by farmers and stake holders in probable accumulation of these anti-nutritional elements in toxic magnitude when grown under shade i.e., as intercrop in orchards and high nitrogen forms hypothesis for the present study.

APBN-1 was the Bajra Napier Hybrid adopted for this study. Developed in 1997 by Andhra Pradesh Agricultural University, it continues to be a popular fodder crop in the states of Telangana and Andhra Pradesh and also in western and central Indian states of Gujarat and Madhya Pradesh, owing to its prolific tillering, high green fodder yield and high preference by cattle (Singh *et al.* 2018) [37]. The effects of growing environments i.e., shade and no-shade under variable levels of nitrogen fertilization on yields, quality and anti-nutritional parameters was studied through a field experiment.

Materials and Methods

Location of study

A field experiment was laid under shade of mango orchard of ARI farm, Rajendranagar, Hyderabad. The mango trees were 30 year old, spaced at 10 m with good branching and healthy canopy. The experiment was conducted between 2013 and 2017 including one year for establishment of crop and was conducted at the peripherals of the orchard in such a way that the growing environments i.e., shade and no-shade which constituted the main treatments were laid out under the shade of orchard and just adjacent to orchard, respectively. This experiment was conducted at $17^0$19'38' N and $78^0$23'35'E at an altitude of 522 m above msl. The weather during the experiment period is presented in Fig.1. The soil of the experimental site was well drained and moderately deep sandy loam with near neutral pH of 7.8 and the electrical conductivity 0.98 dS m^{-1}. The soil status with respect to O.C, available nitrogen, phosphorus and potassium is 0.22%, 184.0, 36.3 and 440 kg ha^{-1}, respectively. The soil bulk density was 1.51 g cc^{-1}.

Treatments

Five levels of nitrogen *viz*., 0% (N_0), 25% (N_{25}), 50% (N_{50}), 100 (N_{100}) and 125% (N_{125}) of state recommended dose of nitrogen formed the sub-treatments. Each treatment was replicated thrice. The state recommended fertilizer schedule for APBN-1 was 40, 60 and 30 kg ha^{-1} of N, P and K, respectively, along with 10 tonnes of FYM as basal besides top dressing with N at rate of 45 kg ha^{-1} after every clipping (Vyavasaya Panchangam, 2014) [48]. Under each main treatment, the five sub-treatments of N namely 0, 25, 50, 100 and 125% of recommended nitrogen were undertaken in three randomized replications. The size of each plot was 4.2 x 4.9 m. The experimental design adopted was two factor Randomized Block Design. After every clipping N was also top dressed following the same gradations *viz*., N_0, N_{25}, N_{50}, N_{100} and N_{125}. Every year P and K @ 60 and 30 kg ha^{-1} and FYM @ 5 t ha^{-1} was applied at the break of monsoon, while N was always scheduled as per the treatments.

Crop establishment

APBN-1 being a sterile hybrid, two budded stem cuttings were used as seed material. The field was thoroughly drenched the day before planting to enable easy planting of stem cuttings. A spacing of 60 cm x 60 cm was followed either way and 20-25 cm long two budded slips were planted inclining at an angle of 45^0 to soil surface with one bud inside soil and the other exposed.

Biometric observations and chemical analysis

Light intensity as received at surface of crop canopy is measured at each clipping. Lux (the SI unit for luminous flux per unit area) was measured with lux meter, Hanna Instruments model HI97500. As the distribution of shade would not be uniform throughout the plot, four observations were taken at four edges of net area of each experimental plot and one in the centre. The average of all these five readings was taken as lux of that particular plot. Standard procedures were adopted for analysis of plant nitrogen (Piper, 1966) [27], crude fiber (Van Soest, 1963) [47], oxalates (Abeza *et al.*, 1968) [1] and nitrates (Downes, 1978) [9]. Crude protein was calculated by multiplying N percent with 6.25. Apart from physico-chemical properties of soil like pH and EC, available N, P K and organic carbon were also estimated. Method recommended by Subbaiah and Asija, 1956 [40] was used for available N estimation while Olsen *et al.*, 1954 [25]; Muhr *et al.*, 1965 [22] and Walkley and Black, 1934 [49] procedures were adopted for estimation of soil P, K and organic carbon respectively.

Statistical analysis

Analysis of variance through two factorial RBD was followed for yield and quality parameters (Snedecor and Cochran, 1994) [39]. The differences were considered if $p<0.05\%$. Correlation between yield and yield attributes was also studied.

Results and Discussion

Yields and yield attributes

The pooled results over three years indicated more plant height in crop grown under shade over sun; however these differences were not significant. The effect of N levels was significant on plant height up to 125% N recording a difference of 13.96% between N_0 and N_{125}. With every level of N applied there was a significant increase in plant height. A 25% increase in fertilizer N over state recommended schedule increased plant height by 3.8%. The leaf: stem (L:S) ratio on the contrary was significantly higher in crop grown under direct sun by 8.64% over the shade grown crop, registering values of 0.88 and 0.81, respectively. Unlike plant height, L:S ratio and tillers/plant increased significantly up to N_{50} and N_{25}, respectively. The crop under sun showed 13.7% more tillers over the crop grown under shade; all the N receiving treatments were on par in this regard but significantly superior over N_0 (Table 1). There was a 10% increase between N_{25} and N_{125} in this regard. Kaur *et al.*, 2017 [16] reported increasing plant height and tillers/plants up to 100 kg ha^{-1} of N. The effect of nitrogen fertilization was prominent in this study on all the yield attributes, almost increasing with increasing N level up to $N_{100/125}$.

The interaction effects indicated significantly higher L:S ratio especially from N_{25} to N_{50} in sun grown crop. Plant height on the contrary, though not significantly increased by shade was remarkably more when grown under an orchard. The negative correlation between plant height and L:S ratio also support these trends (Table 6). These ranges of plant height and tillers/ plant were in conformity to that reported by Toor *et al.*, 2017 [44] in a set of BN hybrids.

Unlike L:S ratio of a maximum of 0.94 registered in this study, Singh *et al.*, 2018 reported higher L:S ratio of 1.2 and higher plant height when APBN-1 was harvested at 90 days interval. The criteria considered for clipping interval could be the reason for lesser plant height in this study, nevertheless effect of shade could also have reduced the L:S ratio. The average tiller number of 36 - 56 tillers/plant reported in this study was much higher than reported by Kaur *et al.*, 2017 [16] and Singh *et al.*, 2018 [37] who reported less than 20 tillers per plant. However, these results were contradictory to those of Chahal (2016) [6] who reported increased plant height when crop was grown under sun.

The green fodder yields (GFY) of the crop grown under shade were significantly lower than their counter parts in sun. The reduction in GFY was to the tune of 9.3% when grown in shade (Table 2). The graded levels of nitrogen also showed a significant increase in GFY up to N_{50} but there after reached a plateau. Between N_{25} and N_{50} there was an increase of a 11.6% in GFY. Significant reduction in green fodder yields when grown as intercrop under shade of orchard was also reported by Damame *et al.*, 2017 [7] in BN hybrid *cv.* 'Phule Jaywant'. Increasing GFY with increase in nitrogen fertilization rates in hybrid Napier geno-types in this study was in conformation to those reported by Tiwana *et al.*, 2004 [43]; Chahal, 2016 [6] and Kaur *et al.*, 2017 [16]. The increase in yields and yield attributes under nitrogen application could be attributed to the several positive effects of nitrogen on the growth and metabolism of crop. Nitrogen being a primary nutrient plays important role in chlorophyll and protein synthesis which reflects in tiller number and consequently yields. A positive correlation between L:S ratio and green fodder yields also support these results. On the contrary a highly negative correlation between plant height and GFY was observed. Nevertheless, the response of crop to added nitrogen is inevitably dependent on the agro-climate of the zone. Zhang *et al.* (2005) [52], Ekemini *et al.* (2012) [10] and Singh *et al.* (2018) [37], reported positive correlation between plant height and fodder yield in napier grass when grown in open field conditions.

The crop grown in sun showed significantly higher dry matter percent (DM %). The dry matter per cent of 18.0 and 19.2 were recorded in crop grown in shade and sun, respectively with a 6.44% variation between them. A significant increase was recorded under sun from N_{50} level onwards. The dry matter per cent at state recommended N was 19.3% and was on par with N_{125}. At every level of N tested the GFY as well as DM% was higher in crop grown in sun. These values are agreeable to those reported in BN hybrids (Antony and Thomas, 2014b; Turano *et al.*, 2016; Singh *et al.*, 2018 and Manoj *et al*., 2020) [4, 46, 37, 15]. Neither plant height nor L:S ratio showed positive correlation with DM%, but a significant positive correlation (p<0.001) was observed with light intensity 'lux'. However, these results are in contrary to those reported by Tudsri *et al*., 2002 [45].

Quality parameters

The crude protein content did not vary with growing environments with values of 9.1 and 8.9% in shade and sun, respectively (Table 3). The N levels significantly influenced CP% with highest value of 9.5% at N_{100}. Crude protein in N_{100} and N_{125} was at par with each other. With a mere 25% of recommended N application there was a 8.33% increase in crude protein in N_{25} over N_0. There was no significant difference between the shade and no-shade treatments with respect to crude fiber. The pooled values over three years also indicated that even the nitrogen levels had not influenced the crude fiber content of plant. Non-significant influence of growing environment on crude protein content was also reported by Damame *et al.*, 2017 [7]. Commendable superiority of APBN-1 in context of CP% among several BN hybrids was also reported by Singh *et al.*, 2018. Turano *et al.*, 2016 however reported lower CP values. Lower crude fiber values ranging between 25 to 27% reported in APBN-1 in this study could be due to the criteria chosen for clipping. Restricted harvesting interval of 90 days could be the reason for higher CF values reported by Singh *et al.*, 2018 [37] and Manoj *et al.*, 2020 [20]. These variations in biomass yield and chemical composition depend on variety, age, season, location and management practices as reported by (Ogoshi *et al.*, 2010 and Xie *et al*., 2011) [24, 51] in napier grass.

Oxalates

Pooled results over the three years of study showed the concentration of oxalates varying between 1.64 to 2.04%, and were significantly affected by shade (Table 3). Sun grown crop accumulated 4.52% higher oxalates over that of shade grown crop. The N levels also affected oxalate concentration. There was a significant increase in oxalate concentration at N_{50} over that of N_0 but there after remained unaffected. The magnitude of oxalates however, rarely exceeded the prescribed 2% limit (Rahman *et al.*, 2013) [32] to affect the animal health. An increase in oxalate concentration with increasing N fertilization from N_0 to N_{100} was observed; but it is also important to observe that all N receiving treatments were on par in this regard. The increase in oxalate content with nitrogen fertilization was reported by Jones and Ford (1972) [14] in *Setaria* species and Damame *et al.*, 2017 [7] in BN hybrid. Non-consistent influence of N levels on oxalate was also reported by Rahman *et al.*, 2010a [29] and Kaur *et al.*, 2016 [17].

Clipping wise variations in oxalates

Narrowing down to understand the accumulation of anti-nutrient factors in every clipping, a detailed study of oxalate concentration in all the eleven clippings was studied (Table 4). The oxalate content increased from first to second year as indicated by increased magnitude from fourth clipping onwards. However, thereafter no clear trends were observed. Out of the 55 situations (11 clippings in 5 N levels) 37 situations showed oxalate accumulation in sun grown crop, 18 accumulations in shade grown crop. To understand variations in oxalates with seasons a look at their concentrations in all the eleven clippings taken indicates rises in their concentrations especially when clipping was done during the months of January, July and October, at almost all levels of N tested. However, these rises could not be explained with seasonal changes as these intervals do not exactly coincide with prominent seasons. For example January clipping could represent peak winter clipping, but July clipping would not represent peak summer clipping compared to May clipping. Similarly clipping taken in October represents a retreating monsoon month. Thus no demarcating trends could be associated in oxalate concentrations in relation to seasons. The oxalates which were the concerns rose by the stake holders were occasionally exceeding 2% in all clippings, overall years studied. The oxalate concentration of sun grown crop is significantly higher than their counter parts. Good growth of crop in sun as evident from yield attributes, GFY, DM% values might lead to more metabolic rates including oxalate metabolism in the crop grown in sun leading to higher oxalate per cent. However, these values rarely crossed the permissible limits from animal health point of view. The values of oxalates reported were lesser/safer than those reported by Antony and Thomas, 2014a [3] and Pathan *et al.*, 2014 [26]. In present study no clear associations of oxalate content with seasons could be established unlike those reported by Rahman *et al.*, 2006 [30] and 2014, Sidhu *et al.*, 2014 [34] and Kaur *et al*., 2016 [17]. The criteria adopted for clipping APBN-1 *viz.*, plant height above 1 m or flowering in about 15% of the population paved way for reduced oxalate concentrations of crop. Several workers reported a highly positive correlation of oxalate concentration with narrow clipping intervals (Antony and Thomas, 2014a; Pathan *et al*., 2014) [3, 26]. In addition to this, as a matter of fact the local agro-climate would play a dominant role in accumulation of these anti-nutritional factors in crops.

Nitrates
The growing environments significantly influenced nitrate concentration with a 7.28% increased accumulation in shade grown crop. The N levels too significantly influenced nitrate concentration with significant increase up to N_{125}; though N_{25} and N_{50} were on par. However, the nitrate concentration increased by 6.5, 1.1, 3.2 and 4.1% between consecutive levels of N from N_0 to N_{125}, respectively. Accumulation of nitrates though observed, was in less than 1000 ppm to affect animal health (Andrea, 2008). Highest value observed in the study was 264 ppm leaving no threat to animals on consumption.

Clipping-wise variations in nitrate concentration
There was a clear increase in nitrate concentration in crop grown under shade over that grown in direct sun in the eleven clippings taken during the period of study (Table 5). First and second years recorded lesser values over the third year which could be due to fact that favorable weather during second year encouraged good crop growth indicating good utilization of added nitrogen thereby accumulation is less. Nitrates were influenced significantly by the growing environments as well as the N levels. Similar reports were made by Chahal, 2016 [6] and Damame *et al.*, 2017 [7]. Though no significant correlation was observed between lux and nitrates, crop grown under shade exhibited more of nitrate accumulation. This could be due to lesser rates of evapo-transpiration as influenced indirectly by lesser lux values under shade. These results are in contrary to those of Damame *et al.*, 2013 [8] who reported nitrate accumulation in toxic concentrations when N @ of 100 kg/ha was applied to pearl millet cv. BAIF bajra. Accumulation of nitrates in toxic concentration may not be possible under the nitrogen levels adopted in this study, besides, sub-tropical agro-climate of Hyderabad with higher temperature maximum values lead to quicker utilization of added N in plant as well as soil preventing accumulation. A negative correlation between oxalate and nitrate concentration was observed here in opposition to those reported by Rahman *et al.*, 2010 [29]; Liu *et al.*, 2015 [19]; however the relation between them is less understood.

Correlation Studies
The correlation matrix as indicated in table showed a strong positive correlation of dry matter% with lux at 1% level of significance. A strong negative correlation (at 1% level of significance) of plant height with L:S ratio and green fodder yields was also observed. Plant height was negatively correlated to nitrate concentration while it was highly positive correlated to oxalate content and crude fiber. L:S ratio was positively correlated with nitrates and GFY while negatively correlated with oxalates (at 1% level of significance) and crude fiber (5% level). Crude protein percent concentration showed highly positive correlation with nitrate content. These correlation studies also indicated a highly significant positive correlations of nitrates and oxalates with crude protein (0.564, 0.604, respectively) at 1% level of significance. However, it is evident that there is no correlation between the oxalate and nitrate concentration in this hybrid. Positive correlations between dry matter per cent and crude fiber% were oberved on the contrary to negative correlations with crude protein. Green fodder yields showed negative correlations with dry matter percent (at 5% level) and crude protein (at 1% level of significance).

Soil status
There was no significant change brought about by growing environments and nitrogen levels on the status of soil pH, EC and available N, P, K during the period of study.

Table 1: Yield attributes of APBN-1 as influenced by growing environment and N levels over three years of study (pooled over three years)

N levels	Plant height (cm)			L:S ratio			Tillers/plant		
	Shade	Sun	Mean	Shade	Sun	Mean	Shade	Sun	Mean
N_0	119	118.9	118.9	0.78	0.81	0.79	36.6	38.0	37.3
N_{25}	127.4	121.6	124.5	0.82	0.82	0.82	42.8	50.8	46.8
N_{50}	127.9	130.5	129.2	0.83	0.92	0.88	46.6	47.9	47.3
N_{100}	132.8	128.1	130.5	0.82	0.92	0.87	45.8	54.6	50.2
N_{125}	137.9	133.1	135.5	0.82	0.94	0.88	46.8	56.2	51.5
Mean	129	126.4		0.81	0.88		43.7	49.5	
		S.Em (+)	**C.D (0.05)**		**S.Em (+)**	**C.D(0.05)**		**S.Em (+)**	**C.D (0.05)**
	Main	1.09	NS		0.009	0.026		1.55	3.63
	Sub	1.72	4.9		0.015	0.042		1.86	6.02
	M x S	2.44	6.93		0.021	0.059		2.22	NS

Table 2: Yields of APBN-1 as influenced by growing environments and N levels over three years of study (pooled over three years)

N levels	GFY (t/ha)			DM%		
	Shade	**Sun**	**mean**	**Shade**	**Sun**	**mean**
N0	65.78	73.58	69.68	17.41	18.32	17.87
N25	70.26	74.54	72.40	18.24	18.54	18.39
N50	77.32	84.40	80.86	18.23	19.26	18.75
N100	76.58	84.46	80.52	18.56	20.14	19.35
N125	72.10	78.74	75.42	17.82	19.80	18.81
Mean	72.41	79.14		18.05	19.21	
		S.Em (+)	C.D (0.05)		S.Em (+)	C.D (0.05)
	Main	0.96	3.12		0.11	0.34
	Sub	1.80	4.87		0.24	0.68
	M x S	2.11	6.08		0.32	0.90

Table 3: Quality and anti-quality parameters of APBN-1 as influenced by growing environments and N levels over three years of study (pooled over three years)

N levels	CP (%)			CF (%)			Oxalates (%)			Nitrates (ppm)		
	Shade	**Sun**	**mean**	**Shade**	**Sun**	**mean**	**Shade**	**Sun**	**mean**	**Shade**	**Sun**	**mean**
N0	8.5	8.2	8.4	25.2	25.6	25.5	1.64	1.70	1.67	163.4	160	161.7
N25	9.2	8.9	9.1	25.3	25.3	25.4	1.73	1.82	1.78	177.8	166.7	172.3
N50	9.0	9	9.0	25.9	25.9	25.9	1.81	1.85	1.83	182.1	166.1	174.1
N100	9.6	9.3	9.5	26.3	26.3	26.3	1.73	2.04	1.89	186.7	172.5	179.6
N125	9.0	9.3	9.2	26.1	26.5	26.3	1.92	1.85	1.89	195.3	178.6	187.0
Mean	9.1	8.9		25.8	25.9		1.77	1.85		181.1	168.8	
		S.Em (+)	C.D(0.05)		S.Em (+)	C.D(0.05)		S.Em(+)	C.D(0.05)		S.Em(+)	C.D(0.05)
	Main	0.07	NS		0.13	NS		0.03	0.07		0.9	2.7
	Sub	0.12	0.35		0.21	NS		0.04	0.13		1.5	4.3
	M x S	0.17	0.49		0.3	0.85		0.06	0.19		2.1	6.2

Table 4: Clipping wise variations in oxalate concentration (%) during the period of study

N level →	N_0		N_{25}		N_{50}		N_{100}		N_{125}		Mean
Cut, month	**shade**	**sun**	**shade**	**sun**	**shade**	**sun**	**shade**	**sun**	**shade**	**sun**	
1 cut, Aug	1.41	1.51	1.40	1.65	1.50	1.42	1.42	1.63	1.77	1.62	1.53
2 cut, Nov	1.14	1.26	1.43	1.50	1.49	1.61	1.54	2.19	1.60	1.67	1.54
3 cut, Feb	1.26	1.42	1.44	1.50	1.55	1.54	1.40	1.59	1.57	1.56	1.48
4 cut, May	1.65	1.69	1.78	1.80	1.77	1.87	1.70	1.90	1.98	1.82	1.80
5 cut, Aug	1.80	1.82	1.80	1.87	1.84	1.99	1.89	2.06	2.06	1.95	1.91
6 cut, Nov	1.92	1.88	2.05	2.11	2.20	2.11	2.13	2.19	2.28	2.03	2.09
7 cut, Feb	1.91	1.96	2.20	1.96	2.15	2.05	2.21	2.15	2.48	2.11	2.12
8 cut, May	1.56	1.50	1.57	1.61	1.59	1.80	1.58	1.74	1.57	1.67	1.62
9 cut, Sep	1.65	1.70	1.59	1.61	2.09	1.69	1.72	2.02	1.68	1.67	1.74
10 cut, Jan	1.87	1.81	1.71	2.00	1.70	1.97	1.32	2.36	1.91	1.90	1.85
11 cut, May	1.95	2.10	2.09	2.38	2.06	2.33	2.14	2.61	2.20	2.38	2.22
Mean	1.65	1.70	1.73	1.82	1.81	1.85	1.73	2.04	1.92	1.85	1.65

Table 5: Clipping wise variations in nitrate concentration (ppm) during the period of study

N level →	N_0		N_{25}		N_{50}		N_{100}		N_{125}		Mean
Cut, month	**shade**	**sun**	**shade**	**sun**	**shade**	**sun**	**shade**	**sun**	**shade**	**sun**	
1 cut, Aug	147	160	173	165	175	177	197	182	208	187	177
2 cut, Nov	161	166	166	177	183	176	185	186	190	197	179
3 cut, Feb	149	141	162	167	180	149	193	167	199	185	169
4 cut, May	127	127	135	129	128	140	125	127	147	130	132
5 cut, Aug	143	140	137	138	136	153	145	143	155	145	144
6 cut, Nov	157	147	165	163	175	166	172	158	179	153	164
7 cut, Feb	155	156	181	147	170	160	180	153	201	162	167
8 cut, May	213	199	249	212	264	207	272	241	272	237	237
9 cut, Sep	175	173	201	172	209	165	190	181	200	186	185
10 cut, Jan	189	171	186	174	171	155	175	160	177	172	173
11 cut, May	158	165	172	168	186	189	190	198	218	188	183
Mean	161	159	175	165	180	167	184	172	195	177	173

Table 6: Correlation matrix of light intensity, yield attributes, yields, quality and anti-quality parameters of bajra napier hybrid under the influence of various forms of nitrogen

	Lux	Plt. Ht.	L:S ratio	Nitrates	oxalates	GFY	DM%	CP%	CF%
Lux	1	-0.081NS	0.180NS	-0.038NS	0.142NS	-0.062NS	0.474**	0.219NS	0.001NS
Plt. Ht.		1	-0.864**	-0.434*	0.713**	-0.530**	0.301NS	0.057NS	0.696**
L:S ratio			1	0.692**	-0.566**	0.435*	0.023NS	0.201NS	-0.478**
Nitrates				1	-0.057NS	-0.075NS	0.146NS	0.564**	-0.255NS
oxalates					1	-0.922**	0.471**	0.604**	0.378*
GFY						1	-0.398*	-0.732**	-0.171NS
DM%							1	0.522**	0.447*
CP%								1	-0.013NS
CF%									1

(* 5% level of significance, **1% level of significance, NS: non-significant)

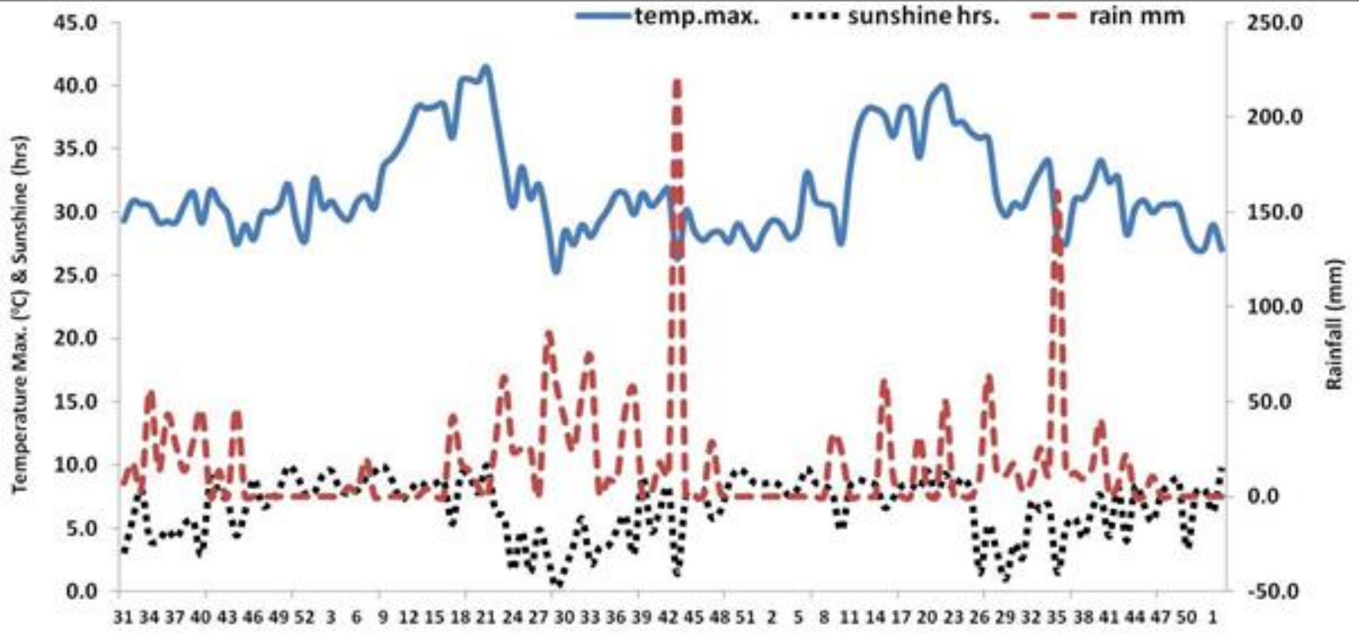

Fig 1: Temperature, rainfall and sun shine hours in standard weeks during experimentation

Conclusions

The increasing popularity of growing bajra napier hybrids as intercrop in orchards comes with a threat of reduced green fodder yields and increased magnitude of nitrates. Shade reduced tiller number and l:s ratio which had its negative effect on dry matter percent. The protein percent and fiber were not significantly affected. The stake holder's concern on oxalates proved defeated as their concentration was not increased under orchards; nitrates on the contrary increased with shade and nitrogen application. The magnitude to oxalates occasionally crossed the permissible limits, which calls for further research to probe the effect on animal health. Nitrates though increased under shade, their values were not high enough to affect animal health. This study infers that growing BN hybrid APBN-1 under shade of an orchard under different N levels did not show any accumulation of anti-nutritional factors *viz.*, oxalates or nitrates in concentrations that are toxic to animals. However, continuous feeding of BN hybrids grown under shade to livestock need frequent monitoring for anti-nutritional elements in southern Telangana agroclimatic zone of the country.

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