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RESEARCH PAPER

Effect of spent-wash based bio-compost on growth and yield of hybrid Bajra-Napier fodder grass

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Abstract: A field experiment was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during 2019-2020 to ascertain the effect of spent-wash based bio-compost and inorganic fertiliser in randomised block design on growth and yield of perennial hybrid Bajra-Napier (COBN-5). The application of bio-compost was based on nitrogen requirement of the hybrid Bajra-Napier. The results revealed higher plant height, number of tillers, leaf area, due to the application of spent-wash based bio compost. Yield parameters like fresh biomass, leaf and stem fresh weight were also in positive correlation with morphological parameters. Physiological traits *viz.* chlorophyll content (2.89mg g^{-1}fr wt), relative water content (62.57%), brix percentage (3.05 %), membrane injury index (26.75 %), photosynthetic rate (26.08µmole CO_2 cm^{-2} sec^{-1}), stomatal conductance (0.423 mol H_2O $m^{-2}s^{-1}$), transpiration rate (10.32 mmol $H_2Om^{-2}s^{-1}$) and internal carbon dioxide - Ci out (266.98 ppm) were comparable with application of inorganic fertilizer. It was evident from the results that dependency on inorganic nutrition can be minimized with the replacement of organic fertilisers *i.e.* spent-wash based bio-compost without affecting the soil health.

Key words: Chlorophyll, Hybrid Bajra-Napier, Physiological parameters, Spent-wash

Introduction

Many issues often plague Indian agriculture. Depleting soil health, mismanagement in irrigation, ill planned cropping systems and vagaries of climate change has affected the livelihood of the farming community. With a large number of marginal and small-scale landholdings, dependency on livestock is inevitable for agricultural production. Healthy livestock is the backbone of Indian agriculture. However, the fodder availability falls far short of the requirement because most of the land is being used for the production of food and cash crops (Dikshit and Birthal, 2010). Under the circumstances, India being the motherland for largest livestock population in the world is mainly depends on crop residues like grasses, weeds and dried crop residues to feed the livestock. Unfortunately, the quality of the fodder is also compromised as the production itself at stake. Hence, fodder scarcity has become the bottleneck in improving livestock productivity. Consequently, the demand for fodder for fulfilling the requirement of the livestock population will also increase. To meet out the increasing demand of fodder, uniform legislation is essential to set apart a specific portion of the land for fodder production because any regional deficits cannot be fulfilled mostly for fodder, because economically it is not a viable option to transport over long distances. The fodder concentrates are expensive and may not be affordable to most of the farmers. Hence, all-out efforts to grow more fodder crops which are known to be a cheaper source of nutrients need to be addressed. Bajra-Napier is a hybrid developed by crossing common Bajra (*Pennisetum glacum* L.) with Napier grass (*Pennisetum purpureum*). It is a perennial, heavy tillering grass with leafiness of bajra with a height of 3-4 m and leaves particularly near the stem are profusely hairy and stiff. It provides nutritional green fodder round the year containing 8.2 per cent protein, 34 per cent crude fibre, 10.5 per cent ash with calcium and phosphorus in proper balance. It is a cut-and-carry forage for stall feeder systems and suitable for hay and silage making. Hybrid Bajra-Napier is also used as a soil stabiliser in soil conservation methods and can be intercropped with various forage legumes.

Inorganic fertilisers are used to improve yield in any crop. However, inorganic fertilisers are known to pollute soil and water bodies. So a recently using organic fertilisers and organic farming is gaining interest among farming community. Hence a study was conducted to understand the role of the organic fertiliser spent wash in improving yield, quality and its morphological and physiological parameters of fodder hybrid Bajra Napier.

Material and methods

A field experiment was carried out during *kharif* 2019, on a pre-established hybrid Bajra-Napier perennial fodder crop at Dairy unit of University of Agricultural Sciences, Dharwad to ascertain the effect of organic and inorganic fertiliser combinations on the growth and yield attributes. The application of organic source of fertiliser-spent wash-based bio compost (N:P:K-1.2% :0.8% : 0.4%)and inorganic fertilisers DAP, MOP and urea were based on the nutrient requirement fodder crop.The experimental plot was laid out in randomised complete block design (RCBD) with 3 replications and 7 treatments. Plant height was measured from the base of the plant to the tip of the terminal leaf using meter scale, number of tillers were counted manually, the leaf area of the 3rd leaf was calculated by the formula *i.e.* Leaf area (cm^2leaf^{-1}) =A × B × K. Whereas, A = length of the leaf blade, B= maximum width of the

leaf blade, K= constant. K - constant value for hybrid Bajra-Napier grass 2/3 (Anikive and Kutuzou 1961). The plants were harvested after every 45 days after application of organic and inorganic fertilisers. The plants were harvested by leaving 10 cm of the stem. Leaves and stem were separated and weighed separately and expressed as g plant^{-1}. The leaf-stem ratio calculated as a ratio of fresh weight of leaves to stem. Relative water content was calculated by using formula given by Pieczynski *et al*. (2013), chlorophyll content was estimated according to Hiscox and Israeistam (1979), membrane injury index was estimated by using formula given by Sullivan and Ross, 1979. Refractive index refractometer was used to measure Brix ratio using stem sap. The photosynthetic rate, stomatal conductance, transpiration rate and Ci out were measured by using IRGA LI6400XT with leaf chamber having an area 2 cm^2.

Statistical analysis was conducted using WASP-2 (Web Agri Stat Package 2.0) hosted by CARI Goa (www.ccari.res.in). The CD values were calculated wherever the F-test was significant and denoted using Duncans Multiple Range Test (DMRT).

Results and discussion

Intensive agriculture with synthetic fertilisers has increased the turbulence because of the higher accumulation of pollutants in all facets of the environment. An intervention is essential in the inorganic cultivation of crops for both food and fodder. The emphasis on the use of eco-friendly agricultural practices are essential and the awareness towards the acceptability to use non-synthetic fertilisers need to be strengthened (Kannaiyan, 2000).

Plant height is the visually most evident morphological character, especially in any fodder crop because it is directly proportional to biomass obtained. Application of 150 % RDN through spent wash based bio compost (T_3) showed significantly higher plant height (145.9 cm) and was on par with 150 % RDN through inorganic fertilisers (T_5) Whereas; least plant height (109.7 cm) was recorded in farmer's practice. Application of organic fertilisers are better known for improving the decomposition of the organic matter and mineralization of nutrients (Table 1). Montemurro *et al.*(2006) has also inferred the improved growth characteristics in alfalfa and cocksfoot due to the increased application of Municipal Solid Waste compost (MSW) and Olive Pomace Compost (OPC) due to the enhanced decomposition of the organic matter and mineralization of nutrients. The data on number of tillers (Table 1) recorded, significantly higher number of tillers (25.33) in treatment receiving 150 per cent RDN through spent wash based bio compost and lowest (15.67) was recorded in treatment receiving farmer's practice. Leaf area (Table 2) was also recorded highest (192.51 cm^{2}leaf^{-1}) in the treatment receiving 150 per cent RDN through spent wash based bio compost and lowest (119.89 cm^{2}leaf^{-1}) was recorded in treatment receiving farmers practice. The above mentioned morphological traits were also similar to the findings of Vennila and Sankaran (2017) where they studied effect of nutrients on the growth and yield of Bajra-Napier grass and concluded that 100 per cent recommended dose of nutrients per ha resulted in higher plant height (157.9 cm) and the number of tillers per plant (31.4), Islam *et al.* (2020) investigated the production characteristics of Ruzi grass by varying levels of organic and inorganic fertilisers, the best combination of fertiliser recommended as per investigation was 50 kg/ha urea fertiliser and 10 t/ha cow dung to obtain better results.

Fodder crops with higher biomass accumulation are preferred in the farming community. In the present investigation significantly higher biomass (52.35 t/ha) was recorded with 150 % RDN through spent wash based bio compost and the lowest (27.69 t/ha) was recorded with farmer's practice (Table 2). Similarly highest leaf fresh weight (1250.76 g plant^{-1}) with150 % RDN through spent wash based bio compost followed by 150 % RDN through inorganic fertilisers and the lowest (465.33 g plant^{-1}) was recorded with Farmer's practice. Stem fresh weight also followed the similar trend. Leaf to stem ratio (Table 2) refers to the leafiness of the fodder and forage crops. It is vital to know about leaf to stem ratio, that if it is high, the proportion of leaves is more compared to the stem if it is less vice versa. Treatment receiving 50 per cent RDN through spent wash based bio compost records higher leaf to stem ratio (1.81) among all treatments. Oad *et al.* (2004) has opined that all the maize parameters were significantly affected by the incorporation of FYM and nitrogen levels in the field experiment

Table 1. Effect of spent wash based bio-compost on morphological traits of hybrid Bajra-Napier

Treatment	Plant height (cm)	Number of tillers	Fresh biomass(t/ha)
T_1 - 50 % RDN through Spent wash-based Bio compost	116.6^{d}	18.67^{e}	32.66^{c}
T_2 - 100 % RDN through Spent wash-based Bio compost	126.0^{bc}	22.67^{bc}	43.26^{b}
T_3 - 150 % RDN through Spent wash-based Bio compost	145.9^{a}	25.33^{a}	52.35^{a}
T_4 - 100% RDN through inorganic fertilizer (180:120:80 kg NPK ha^{-1})	129.7^{b}	21.67^{cd}	41.23^{b}
T_5 - 150% RDN through inorganic fertilizer (270:120:80 kg NPK ha^{-1})	142.4^{a}	24.67^{ab}	48.98^{a}
T_6 - 50 % RDN through inorganic fertilizer + 50 % RDN through Spent wash-based Bio compost	119.8^{cd}	19.67^{de}	35.71^{c}
T_7 - Farmer's practice (100 kg DAP + 50 kg urea + 2 tonnes of FYM).	109.7^{e}	15.67^{f}	27.69^{d}
Mean	127.2	21.17	40.26
S.Em.±	2.02	0.82	1.47
L.S.D. at 5%	6.25	2.54	5.45

RDN- Recommended dose of Nitrogen

Note: DMRT: Values in the column followed by the same letter do not differ significantly (NS)

Table 2. Effect of spent wash based bio - compost on morphological traits of hybrid Bajra-Napier

Treatment	Leaf area ($cm^2 leaf^{-1}$)	Leaf fresh weight (g $plant^{-1}$)	Stem fresh weight (g $plant^{-1}$)	Leaf to stem ratio
T_1 - 50 % RDN through Spent wash-based Bio compost	128.65^{de}	843.46^{cd}	464.26^{d}	1.81^{a}
T_2 - 100 % RDN through Spent wash-based Bio compost	159.73^{b}	893.10^{cd}	904.86^{b}	0.98^{de}
T_3 - 150 % RDN through Spent wash-based Bio compost	192.51^{a}	1250.76^{a}	1215.67^{a}	1.02^{d}
T_4 - 100% RDN through inorganic fertilizer (180:120:80 kg NPK ha^{-1})	142.52^{c}	972.20^{bc}	869.77^{b}	1.11^{c}
T_5 - 150% RDN through inorganic fertilizer (270:120:80 kg NPK ha^{-1})	188.39^{a}	1100.10^{b}	1167.90^{a}	0.94^{e}
T_6 - 50 % RDN through inorganic fertilizer + 50 % RDN through Spent wash-based Bio compost	132.65^{cd}	787.63^{d}	537.23^{c}	1.46^{b}
T_7 - Farmer's practice (100 kg DAP + 50 kg urea + 2 tonnes of FYM).	119.89^{e}	465.33^{e}	423.36^{d}	1.09^{c}
Mean	152.05	901.79	797.58	1.20
S.Em.±	3.32	47.28	22.67	0.017
L.S.D. at 5%	10.25	145.69	69.87	0.051

RDN- Recommended dose of Nitrogen

Note: DMRT: Values in the column followed by the same letter do not differ significantly (NS)

on the maize growth and fodder yield under varying combinations of organic manure. It was concluded that inorganic nitrogen application is the common practice of farmers, but supplement farmyard manure helps to get a significantly high yield of fodder maize.

Leaf relative water content (RWC) is an important indicator of water status in plants; it reflects the balance between water supply to the leaf tissue and transpiration rate (Lugojan and Ciulca 2011).In the present study, relative water content (Table 3) was recorded highest in treatment receiving 150 % RDN through Spent wash-based Bio compost (67.33%) and least was recorded in farmer's practice (45.87%). Disintegrated cell membranes (Cell membrane injury) indicate plants are stressed. It is a passive efflux of ions from cytosol and leads to death of the tissue (Levitt, 1980)Among all treatments, T_5 (150 % RDN through inorganic fertilisers) has highest membrane injury index (Table 3) followed T_4(100 % RDN through inorganic fertiliser)and T_2(100% RDN through spent wash based bio compost) whereas, lowest membrane injury index recorded in T_7(Farmer's practice) indicating higher dose of fertiliser may affect disintegration of cell membranes. Chlorophyll differed significantly, with respect to organic and inorganic fertiliser application. Application of 150 % RDN through spent wash based bio compost recorded highest chlorophyll content (3.00 mg g fr wt^{-1}) followed by 150 % RDN through inorganic fertilisers. Whereas, lowest (1.56 mg g fr wt^{-1}) was recorded in Farmer's practice. Brix value is important for the taste and quality of fodder crops which improves the palatability. In the present investigation, Brix percentage was higher (3.05 %) with 150 % RDN through spent wash based bio compost followed by 150 % RDN through inorganic fertilisers, 100% RDN through spent wash based bio compost and 100 % RDN through inorganic fertiliser, whereas, the least (1.56 %) was recorded in Farmer's practice.

The photosynthetic rate was significantly higher when compared to control in all treatments (Table 3). The higher photosynthetic rate(26.08µ mole CO_2 cm^{-2} sec^{-1}) was observed in 150 % RDN through spent wash based bio compost followed by 150 % RDN through inorganic fertilisers and least (20.35 µ mole CO_2 cm^{-2} sec^{-1}) was observed in Farmer's practice. Other parameters like stomatal conductance, transpiration rate, Ci out was also in positive correlation with photosynthetic rate.Stomatal conductance do not show much significant difference among all treatments. Highest stomatal conductance

Table 3.Effect of spent wash based -bio compost on physiological traits of hybrid Bajra-Napier

Treatment	Relative water content (%)	Membrane injury index (%)	Chlorophyll content (mg g fr wt^{-1})	Brix percentage (%)
T_1 - 50 % RDN through Spent wash-based Bio compost	48.57^{e}	19.65^{d}	1.78^{de}	1.65^{d}
T_2 - 100 % RDN through Spent wash-based Bio compost	59.63^{bc}	26.38^{ab}	2.35^{b}	2.36^{b}
T_3 - 150 % RDN through Spent wash-based Bio compost	67.33^{a}	25.91^{b}	3.00^{a}	3.05^{a}
T_4 - 100% RDN through inorganic fertilizer (180:120:80 kg NPK ha^{-1})	55.54^{cd}	26.75^{ab}	2.08^{c}	2.12^{c}
T_5 - 150% RDN through inorganic fertilizer (270:120:80 kg NPK ha^{-1})	63.42^{ab}	27.43^{a}	2.76^{a}	2.96^{a}
T_6 - 50 % RDN through inorganic fertilizer + 50 % RDN through Spent wash-based Bio compost	50.28^{de}	24.00^{c}	1.91^{cd}	1.98^{c}
T_7 - Farmer's practice (100 kg DAP + 50 kg urea + 2 tonnes of FYM).	45.87^{e}	16.45^{e}	1.56^{e}	1.56^{d}
Mean	55.8	23.79	2.2	2.24
S.Em.±	1.83	0.39	0.083	0.051
L.S.D. at 5%	5.65	1.25	0.256	0.180

RDN- Recommended dose of Nitrogen

Note: DMRT: Values in the column followed by the same letter do not differ significantly (NS)

Table 4. Effect of spent-wash based bio - compost on other physiological parameters of hybrid Bajra-Napier

Treatment	Photosynthetic rate (μ mole CO_2 cm^{-2} sec^{-1})	Stomatal conductance (mol H_2O $m^{-2}s^{-1)}$	Transpiration rate (mmol H_2O $m^{-2}s^{-1}$)	Ci out (ppm)
T_1 - 50 % RDN through Spent wash-based Bio compost	21.62[d]	0.168[bc]	2.58[f]	189.00[e]
T_2 - 100 % RDN through Spent wash-based Bio compost	23.50[bc]	0.270[b]	6.68[c]	219.64[c]
T_3 - 150 % RDN through Spent wash-based Bio compost	26.08[a]	0.423[a]	10.32[a]	266.98[a]
T_4 - 100% RDN through inorganic fertilizer (180:120:80 kg NPK ha^{-1})	22.48[cd]	0.211[bc]	5.44[d]	207.38[d]
T_5 - 150% RDN through inorganic fertilizer (270:120:80 kg NPK ha^{-1})	24.56[b]	0.268[b]	8.17[b]	242.15[b]
T_6 - 50 % RDN through inorganic fertilizer + 50 % RDN through Spent wash-based Bio compost	22.07[d]	0.223[bc]	4.16[e]	196.41[e]
T_7 - Farmer's practice (100 kg DAP + 50 kg urea + 2 tonnes of FYM).	20.35[e]	0.115[c]	2.56[f]	160.26[f]
Mean	22.94	0.239	5.7	211.68
S.Em.±	0.41	0.035	0.082	3.12
L.S.D. at 5%	1.27	0.109	0.3525	9.62

RDN- Recommended dose of Nitrogen

Note: DMRT: Values in the column followed by the same letter do not differ significantly (NS)

was recorded by 150 % RDN through spent wash based bio compost, followed by 150 % RDN through inorganic fertilisers and the least was observed in Farmer's practice. However, highest transpiration rate was observed in 150 % RDN through spent wash based bio compost (10.32 m mol H_2O $m^{-2}s^{-1}$) followed by 150 % RDN through inorganic fertilisers and the lowest was observed in Farmer's practice. Ci out also differed significantly among all treatments. Highest (266.98 ppm) Ci out was recorded by 150 % RDN through spent wash based bio compost, followed by 150 % RDN through inorganic fertilisers (242.15 ppm) and least (160.26 ppm) was observed by Farmer's practice. The results of our present investigation were in accordance with studies conducted by Adejumo *et al.* (2016) in maize, Adebayo *et al.* (2020), Bilalis *et al.* (2018), also opined that application of manures plays a vital role in overall growth and yield of both arable crops and fodders.

Conclusion

The present study established a confirmed and comprehensive interaction of organic *i.e*. Spent wash bio-compost and inorganic fertilisers impact on yield potential (biomass) of perennial hybrid Bajra-Napier (COBN-5) which can be further investigated to ascertain the long-term use of spent wash based bio-compost on soil health.

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