Performance of Planting Methods and Sett Treatments on Quality, Nutrient Uptake and Economics of Bajra Napier Hybrid Grass (Pennisetum glaucum L. X P. purpureum schumach)

S. V. Varshini1*, C. Jayanthi1, S. D. Sivakumar2, A. Senthil3, P. Malarvizhi4 and R. Karthikeyan1

1Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
2Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
3Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
4Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.

Authors’ contributions

This work was carried out in collaboration among all authors. Author SVV designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CJ, SDS and AS managed the analyses of the study. Authors PM and RK managed the literature searches. All authors read and approved the final manuscript.

ABSTRACT

A field experiment to assess the effect of planting methods and sett treatments on quality, nutrient uptake and economics of bajra napier hybrid grass CO (BN) 5 was conducted during 2018-2019 at the Eastern block farm of the Department of Agronomy, Tamil Nadu Agricultural University – Coimbatore, Tamil Nadu. The experimental field was laid out in factorial randomized block design. The main plots were vertical planting (M1) and horizontal planting (M2) and sub-plots were 13 sett treatments. The results on some quality parameters viz., crude protein, crude fibre, crude fat, total ash contents (%), showed non-significant difference on planting methods, sett treatments and their
interaction. Among planting methods, vertical planting had registered higher crude protein yield of 1.23 t ha⁻¹, nitrogen uptake (151 kg ha⁻¹), phosphorus uptake (23.4 kg ha⁻¹) and potassium uptake (87.7 kg ha⁻¹). Among sett treatments, water soaking for 12 hours and 24 hours incubation (S₁) significantly registered higher crude protein yield (1.78 t ha⁻¹), nitrogen uptake (186.8 kg ha⁻¹), phosphorus uptake (31.9 kg ha⁻¹) and potassium uptake (108.4 kg ha⁻¹). In two planting methods, low cost of cultivation ($629 ha⁻¹), higher gross return ($1227 ha⁻¹), net return ($598 ha⁻¹) and benefit cost ratio (1.98) were registered with vertical planting (M₁). Similarly, among sett treatments, water soaking for 12 hours and 24 hours incubation (S₁) recorded lower cost of cultivation ($563 ha⁻¹), higher gross return ($1698 ha⁻¹), net return ($1135 ha⁻¹) and benefit cost ratio (3.02). With this, it can be concluded that for planting method, vertical planting (M₁), and for sett treatment, water soaking for 12 hours and 24 hours incubation (S₁) are the recommended practices for achieving better quality, nutrient uptake and economics from bajra napier hybrid grass.

Keywords: Planting methods; sett treatments; baja napier hybrid grass; quality and nutrient uptake.

1. INTRODUCTION

Livestock plays an important role in Indian economy. At present, India faces a critical imbalance in its natural resource base with about 18% human and 15% of livestock population of the world being supported only by 2.4% of geographical area, 1.5% of forest and pasture lands and 4.2% of water resources [1]. Presently, there is stress on accessibility of forage and feed, as cultivated land for fodder cultivation has been declining. Currently, India is facing shortfall of around 64% feeds, 61.1% green fodder and 21.9% dry crop residues [2].

In order to meet the growing demand of nutritious green fodder for livestock, it is essential to introduce high yielding fodder varieties of grasses, millets and legumes. One such among the cultivated perennial grasses is the bajra napier hybrid grass, acclaimed as the highest forage yielder in a unit time and space. Among the bajra napier grasses, B.N hybrid grass CO (BN) 5 is an inter-specific hybrid between bajra IP 20594 [Pennisetum glaucum (L.) R. Br.] and napier grass FD 437 (P. purpureum schumach) produced throughout the year with heavy yielding potential [3].

Planting methods and number of buds per sett was known to have considerable effect on sprouting and subsequent growth of vegetatively propagated crops [4]. This large mass of planting material poses a great problem in transport, handling, sett material storage etc. The huge stuff of sett material is also prone to disease's attack and undergoes rapid deterioration thus reducing the viability of buds and subsequently their sprouting. Thus, more number of setts is required to get one healthy seedling from the stock [5]. Therefore, by using the single budded setts considerably reduces the amount of planting material requirement as well as they are easy to transport [6].

In addition, pre-planting treatments can be used to protect the crop from soil borne diseases, sett rotting and damage to buds which affect germination [7]. It may improves the 60% of germination by sett treatment which is quite simple and cheap [8]. Most of the farmers use two or three-budded setts as planting materials without pre-planting treatments, but two or three-budded setts cannot give uniform germination as of an individual bud and damage to setts cause large gaps. To overcome poor germination and poor crop stand, a suitable sett treatments, sett size and planting methods are essential for bajra napier hybrid grass cultivation.

In order to address these problems, this research was conducted to evaluate the effectiveness of various planting methods and pre planting sett treatments for identifying suitable planting method and pre planting sett treatment for bajra napier hybrid grass that could account for better crop productivity and economy.

2. MATERIALS AND METHODS

A field experiment was conducted during 2018-2019 in Field No. 75 at the Eastern block farm of Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The soils in the experimental field are sandy clay loam in texture. Climatic conditions prevailed during cropping period were with rainfall of 68.6 mm, maximum minimum temperatures of 31°C and 23°C respectively and relative humidity during morning and evening of 86 and 57% respectively.
based on the data provided by Agroclimate research centre, Tamil Nadu Agricultural University. The chemical analysis of soil indicated that the soil was low in available nitrogen (205 kg ha\(^{-1}\)), high in available phosphorus (33 kg ha\(^{-1}\)) and high in available potassium (769 kg ha\(^{-1}\)). It was moderately alkaline in reaction (pH 8.49) with 0.55 dSm\(^{-1}\) electrical conductivity. The organic carbon content was 0.57%. The variety adapted for the study was CO (BN) 5 bajra napier hybrid grass.

The experimental field was laid out in factorial randomized block design (FRBD) with two replications. Main plots comprised of planting methods with vertical (M\(_1\)) and horizontal planting (M\(_2\)) and sub plots with thirteen sett treatments viz., water soaking for 12 hours and 24 hours incubation (S\(_1\)), water soaking for 30 minutes (S\(_2\)), hot water soaking at 40°C for 20 minutes (S\(_3\)), cowdung slurry (1:1) soaking for 30 minutes (S\(_4\)), panchagavya (3%) soaking for 30 minutes (S\(_5\)), panchagavya (5%) soaking for 30 minutes (S\(_6\)), beejamruth (soaking concentrated solution for 30 minutes) (S\(_7\)), beejamruth (50% dilution) soaking for 30 minutes (S\(_8\)), GA3 (5 ppm) soaking for 15 minutes (S\(_9\)), GA3 (10 ppm) soaking for 15 minutes (S\(_{10}\)), ethrel (50 ppm) soaking for 15 minutes (S\(_{11}\)), ethrel (100 ppm) soaking for 15 minutes (S\(_{12}\)), control (without sett treatment) (S\(_{13}\)). The field was thoroughly ploughed and applied with recommended dose of NPK 75:50:40 kg ha\(^{-1}\) at basal, subsequently 75 kg ha\(^{-1}\) of nitrogen was applied at 30 days after planting (DAP).

The single budded setts were treated as per treatment schedule and planted vertically and horizontally in their respective plots with a spacing of 60 x 50 cm in the month of July. First irrigation was given at the time of planting and life irrigation was provided on 3 DAP. Subsequent irrigations were given at 10 days interval. Hand weeding was done on 20 DAP. The samples used for analysis were taken at 75 DAP during first cut.

The standard analytical methods were used for plant analysis viz., nitrogen (kg ha\(^{-1}\)) estimated through Humphries (1956) [9], phosphorus and potassium (kg ha\(^{-1}\)) by Jackson (1973) [10]. The quality parameters viz., crude protein content was estimated using the method suggested by Humphries (1956) [9], crude fibre content (%) by Goering and Van Soest (1970) [11] while, crude fat content (%) was determined by AOAC (1970) [12] and total ash content (%) was determined by AOAC (1990) [13]. Crude protein yield (t ha\(^{-1}\)) was computed by multiplying the crude protein content with respective dry matter production. The prevailing market prices were taken to work out the economics of different treatments. Also the statistical analysis for all the data pertaining to the crop was carried out using the procedure suggested by Gomez and Gomez (1984) [14]. Wherever the treatment differences were found significant critical difference was worked out at 5% probability level. The treatment differences that were not significant were denoted as ‘NS.

3. RESULTS AND DISCUSSION

3.1 Quality Parameters

The results on quality parameters (Tables 1 & 2) shows that, crude protein content, crude fibre content, crude fat content, total ash content (%) on bajra napier hybrid grass CO (BN) 5 showed non-significant differences among the two planting methods and sett treatments. But, crude protein yield (t ha\(^{-1}\)) showed a marked difference on the planting methods and sett treatments. Whereas, interaction effect of quality parameters showed non-significant difference between planting methods and sett treatments.

3.2 Crude Protein Content (%)

Among the planting methods, horizontal planting (M\(_2\)) registered numerically higher crude protein content of 13.89%. Lower value of 13.68% was observed with vertical planting (M\(_1\)). For sett treatments, water treatment (12 hours soaking and 24 hours incubation) (S\(_1\)) recorded numerically higher value of 14.40%. Numerically lower value of 12.92% was observed with control (without sett treatment) (S\(_{13}\)). With respect to interaction effect of planting methods and sett treatments, horizontal planting with water treatment (12 hours soaking and 24 hours incubation) (M\(_2\)S\(_1\)) recorded numerically higher value of 14.53%. Numerically lower value of 12.43% was registered with vertical planting with control (without sett treatment) (M\(_1\)S\(_{13}\)). Crude protein content of bajra napier hybrid was not influenced significantly due to different planting methods and sett treatments. This might be due to the practice that planting materials were obtained from same origin where did not have influence on quality parameters. This was supported by Pathan et al. [15]. Subsequently, Credo [16] Soriano [17] also reported that equal influence of treatment on planting material.
showed non-significant differences among planting methods with sett treatment.

### 3.3 Crude Fibre Content (%)

Crude fibre content among the planting methods showed numerically higher value of 30.14% with vertical planting (M₁). Numerically lower value of 29.94% was registered with horizontal planting (M₂). For sett treatments, control (without sett treatment) (S₁) recorded numerically higher value of 30.45% and lower value of 29.44% was registered with water treatment (12 hours soaking and 24 hours incubation) (S₂) recorded numerically higher value of 5.23%.

Interaction effect between planting methods and sett treatments showed numerically superior value of 30.46% in vertical planting with control (without sett treatment) (M₁S₁). Lower value of 29.43% was observed with horizontal planting with water treatment (12 hours soaking and 24 hours incubation) (M₂S₁).

Crude fibre is an indirect indication of digestibility of the forage and occupies prime position in the evaluation of forage material. Crude fibre mainly consists of cellulose, hemicellulose and lignin and reduces the digestibility of forage. Crude fibre content was not influenced significantly by different planting methods and sett treatments. However, there had been decreasing trend of crude fibre content with increased nitrogen uptake. Due to higher nitrogen uptake, more rapidly synthesized carbohydrates were produced and converted to protein and protoplasm, only smaller proportion was left available for cell wall material [18]. This might be the reason for non-significant result of crude fibre content. These results were also confirms with the findings of Pathan et al. [15] and Patel and Chaudhary [19].

### 3.4 Crude Fat Content (%)

Results on crude fat content shows that among the planting methods numerically higher value of 4.87% was registered with horizontal planting (M₂). Numerically lower value of 4.84% was recorded with vertical planting (M₁). For sett treatments, water treatment (12 hours soaking and 24 hours incubation) (S₂) registered numerically higher value of 5.20%. Numerically lower value of 4.67% was recorded with control (without sett treatment) (S₁). For regard to interaction effect between planting methods and sett treatments, horizontal planting with water treatment (12 hours soaking and 24 hours incubation) (M₂S₂) recorded numerically higher value of 5.23%. Numerically lower value of 4.65 was observed with vertical planting with control (without sett treatment) (M₁S₁). These

### Table 1. Effect of sett treatments and planting methods on crude protein content and crude protein yield of B. N. hybrid grass

| Treatments                        | Crude protein content (%) | Crude protein yield (t ha⁻² cut⁻¹) |
|----------------------------------|---------------------------|-----------------------------------|
|                                  | M₁ Vertical               | M₂ Vertical               | Mean           | M₁ Horizontal | M₂ Horizontal | Mean           |
| S₁ Water (12 hrs. soaking & 24 hours incubation)        | 14.26                      | 14.53                      | 14.40          | 1.88          | 1.67          | 1.78          |
| S₂ Water (30 minutes)             | 13.14                      | 13.50                      | 13.32          | 1.84          | 0.82          | 0.83          |
| S₃ Hot water                      | 14.01                      | 14.07                      | 14.04          | 1.27          | 1.24          | 1.26          |
| S₄ Cowdung slurry                 | 14.07                      | 14.12                      | 14.10          | 1.49          | 1.38          | 1.44          |
| S₅ Panchagavya 3%                 | 13.77                      | 13.72                      | 13.75          | 1.07          | 0.95          | 1.01          |
| S₆ Panchagavya 5%                 | 13.81                      | 13.83                      | 13.82          | 1.12          | 1.00          | 1.06          |
| S₇ Beejamruth                     | 14.21                      | 14.47                      | 14.34          | 1.80          | 1.66          | 1.73          |
| S₈ Beejamruth 50% dilution        | 14.14                      | 14.25                      | 14.20          | 1.64          | 1.47          | 1.55          |
| S₉ GA3 (5 ppm)                    | 13.70                      | 13.64                      | 13.67          | 1.03          | 0.91          | 0.97          |
| S₁₀ GA3 (10 ppm)                  | 13.95                      | 13.96                      | 13.96          | 1.19          | 1.12          | 1.15          |
| S₁₁ Ethrel (50 ppm)               | 13.33                      | 13.55                      | 13.44          | 0.97          | 0.88          | 0.93          |
| S₁₂ Ethrel (100 ppm)              | 13.04                      | 13.48                      | 13.26          | 0.93          | 0.88          | 0.90          |
| S₁₃ Control                       | 12.43                      | 13.41                      | 12.92          | 0.71          | 0.74          | 0.72          |
| Mean                              | 13.68                      | 13.89                      | 13.73          | 1.23          | 1.13          |                |
| P                                 | 0.31                       | 0.79                       | 1.13           | 0.03          | 0.07          | 0.92          |
| S                                 | NS                         | NS                         | NS             | S             | S             | NS            |
| PXS                               | NS                         | NS                         | NS             | NS            | NS            | NS            |
| CD (P=0.05)                       | NS                         | NS                         | NS             | S             | S             | NS            |
Table 2. Effect of sett treatments and planting methods on crude fibre, crude fat and total ash content of B. N. hybrid grass

| Treatments | Crude fibre content (%) | Crude fat content (%) | Total ash content (%) |
|------------|-------------------------|-----------------------|-----------------------|
|             | M1 Vertical             | M2 Horizontal         | Mean                  | M1 Vertical | M2 Horizontal | Mean | M1 Vertical | M2 Horizontal | Mean |
| S1 Water (12 hrs. soaking & 24 hours incubation) | 29.45 | 29.43 | 29.44 | 5.17 | 5.23 | 5.20 | 11.96 | 12.09 | 12.03 |
| S2 Water (30 minutes) | 30.37 | 30.36 | 30.37 | 4.70 | 4.73 | 4.72 | 10.46 | 10.55 | 10.51 |
| S3 Hot water | 30.19 | 29.70 | 29.95 | 4.87 | 4.90 | 4.89 | 11.21 | 11.26 | 11.24 |
| S4 Cowdung slurry | 29.93 | 29.68 | 29.81 | 4.95 | 4.98 | 4.97 | 11.37 | 11.42 | 11.40 |
| S5 Panchagavya 3% | 30.27 | 30.04 | 30.16 | 4.75 | 4.78 | 4.77 | 10.68 | 10.72 | 10.70 |
| S6 Panchagavya 5% | 30.25 | 29.83 | 30.04 | 4.78 | 4.80 | 4.79 | 10.94 | 10.97 | 10.96 |
| S7 Beejamruth | 29.76 | 29.61 | 29.69 | 5.10 | 5.16 | 5.13 | 11.92 | 11.96 | 11.94 |
| S8 Beejamruth 50% dilution | 29.87 | 29.64 | 29.76 | 5.01 | 5.04 | 5.03 | 11.61 | 11.73 | 11.67 |
| S9 GA3 (5 ppm) | 30.32 | 30.15 | 30.24 | 4.73 | 4.75 | 4.74 | 10.63 | 10.63 | 10.63 |
| S10 GA3 (10 ppm) | 30.22 | 29.75 | 29.99 | 4.80 | 4.82 | 4.81 | 11.02 | 11.05 | 11.04 |
| S11 Ethrel (50 ppm) | 30.35 | 30.24 | 30.30 | 4.72 | 4.76 | 4.74 | 10.53 | 10.58 | 10.56 |
| S12 Ethrel (100 ppm) | 30.41 | 30.39 | 30.40 | 4.69 | 4.70 | 4.70 | 10.42 | 10.47 | 10.45 |
| S13 Control | 30.46 | 30.44 | 30.45 | 4.65 | 4.69 | 4.67 | 10.34 | 10.40 | 10.37 |
| Mean | 30.14 | 29.94 | 30.45 | 4.84 | 4.87 | 4.87 | 11.01 | 11.06 | 11.06 |

| SEd | 0.69 | 1.76 | 2.49 | 0.11 | 2.89 | 0.40 | 0.26 | 0.65 | 0.93 |
| CD (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |
Table 3. Effect of sett treatments and planting methods on cost of cultivation and gross return of B. N. hybrid grass

| Treatments | Cost of cultivation ($ ha⁻¹ cut⁻¹) | Gross return ($ ha⁻¹ cut⁻¹) |
|------------|-----------------------------------|----------------------------|
|            | M₁ Vertical | M₂ Horizontal | Mean | M₁ Vertical | M₂ Horizontal | Mean |
| S₁ Water (12 hrs. soaking & 24 hours incubation) | 550 | 576 | 563 | 1777 | 1619 | 1698 |
| S₂ Water (30 minutes) | 550 | 576 | 563 | 819 | 724 | 771 |
| S₃ Hot water | 550 | 576 | 563 | 1373 | 1158 | 1265 |
| S₄ Cowdung slurry | 560 | 586 | 573 | 1517 | 1240 | 1379 |
| S₅ Panchagavya 3% | 694 | 720 | 707 | 1053 | 994 | 1023 |
| S₆ Panchagavya 5% | 791 | 817 | 804 | 1169 | 1049 | 1109 |
| S₇ Beejamruth | 731 | 758 | 744 | 1737 | 1458 | 1597 |
| S₈ Beejamruth 50% dilution | 671 | 697 | 684 | 1639 | 1316 | 1478 |
| S₉ GA3 (5 ppm) | 568 | 594 | 581 | 1039 | 958 | 998 |
| S₁₀ GA3 (10 ppm) | 588 | 614 | 601 | 1295 | 1098 | 1197 |
| S₁₁ Ethrel (50 ppm) | 643 | 669 | 656 | 925 | 880 | 902 |
| S₁₂ Ethrel (100 ppm) | 736 | 746 | 741 | 876 | 876 | 876 |
| S₁₃ Control | 550 | 576 | 563 | 737 | 705 | 721 |
| Mean | 629 | 661 | 661 | 1227 | 1083 | 1083 |

Table 4. Effect of sett treatments and planting methods on net return and B: C ratio of B. N. hybrid grass

| Treatments | Net return ($ ha⁻¹ cut⁻¹) | B:C ratio |
|------------|--------------------------|-----------|
|            | M₁ Vertical | M₂ Horizontal | Mean | M₁ Vertical | M₂ Horizontal | Mean |
| S₁ Water (12 hrs. soaking & 24 hours incubation) | 1228 | 1043 | 1135 | 3.23 | 2.81 | 3.02 |
| S₂ Water (30 minutes) | 269 | 148 | 209 | 1.49 | 1.26 | 1.38 |
| S₃ Hot water | 824 | 582 | 703 | 2.5 | 2.01 | 2.26 |
| S₄ Cowdung slurry | 957 | 654 | 806 | 2.71 | 2.12 | 2.42 |
| S₅ Panchagavya 3% | 359 | 274 | 316 | 1.52 | 1.38 | 1.45 |
| S₆ Panchagavya 5% | 378 | 232 | 305 | 1.48 | 1.28 | 1.38 |
| S₇ Beejamruth | 1006 | 700 | 853 | 2.37 | 1.92 | 2.15 |
| S₈ Beejamruth 50% dilution | 968 | 619 | 794 | 2.44 | 1.89 | 2.17 |
| S₉ GA3 (5 ppm) | 471 | 363 | 417 | 1.83 | 1.61 | 1.72 |
| S₁₀ GA3 (10 ppm) | 707 | 483 | 595 | 2.2 | 1.79 | 2.00 |
| S₁₁ Ethrel (50 ppm) | 282 | 211 | 247 | 1.44 | 1.32 | 1.38 |
| S₁₂ Ethrel (100 ppm) | 140 | 130 | 135 | 1.19 | 1.17 | 1.18 |
| S₁₃ Control | 187 | 130 | 158 | 1.34 | 1.23 | 1.29 |
| Mean | 598 | 428 | 1.98 | 1.68 | 1.68 |

results were in line with the findings of Pathan et al. [15] who reported that crude fat content of bajra napier hybrid grass was not significantly varied with different planting methods. Subsequently Nithya [20] also reported that same planting material with different planting methods does not show any significant difference on crude protein content of bajra napier hybrid grass. These results are further supported by Shukla and Lal [21].

3.5 Total Ash Content (%)

Among planting methods, horizontal planting (M₂) recorded numerically higher value of 11.06%. Whereas, numerically lower value of 11.01% was registered with vertical planting (M₁). For sett treatments, water treatment (12 hours soaking and 24 hours incubation) (S₁) recorded numerically superior value of 12.03%. Numerically lower value of 10.37% was observed with control (without sett treatment) (S₁₃).
Interaction of planting methods and sett treatments, horizontal planting with water treatment (12 hours soaking and 24 hours incubation) (M2S1) recorded numerically higher value of 12.09%. Lower value of 10.34% was observed with vertical planting with control (without sett treatment) (M1S13). These results were quite in line with the findings of Pathan Sarfrajkhan [22] in bajra napier hybrid grass.

Higher ash content registered on horizontal planting (M2) and water treatment (12 hours soaking and 24 hours incubation) (S1) might be due to higher mineral absorption at initial growth stage which was reflected in higher dry matter yield which in turn increased the ash content. These results were correlated with the findings of Tessema and Alemayehu [23]. Planting methods and sett treatments combination did not exert significant influence on total ash content.

### 3.6 Crude Protein Yield (t ha\(^{-1}\) cut\(^{-1}\))

Significant variation was observed in crude protein yield due to planting methods and sett treatments. But interaction effect between planting methods and sett treatments had non-significant difference on crude protein yield. Crude protein yield was significantly higher under vertical planting (M1) which recorded 1.23 t ha\(^{-1}\) cut\(^{-1}\). The lower crude protein yield of 1.13 t ha\(^{-1}\) cut\(^{-1}\) was registered with horizontal planting (M2). Regarding sett treatments, higher crude protein yield of 1.78 t ha\(^{-1}\) cut\(^{-1}\) was recorded with water treatment (12 hours soaking and 24 hours incubation) (S1). Lower crude protein yield of 0.72 t ha\(^{-1}\) cut\(^{-1}\) was observed with control (without sett treatment) (S13). Though crude protein content not varied with different planting methods and sett treatments, crude protein yield differed significantly. Since the crude protein yield is derived by multiplying crude protein percentage with dry matter yield.

Among planting methods used, vertical planting registered higher crude protein yield. Due to early establishment on vertical planting and sett treatment, it absorbed more nutrients and produced more herbage yield with higher accumulation of dry matter and crude protein content in plants, which in turn increased crude protein yield [24] and [25]. This finding corroborate with the results of Sinare et al. [26]. Similar findings by Pathan et al. [15] also states that, this might be due to superior vegetative growth attributes and more green forage yield resulted in higher dry matter accumulation which resulted in higher crude protein yield. Further the lower crude protein yield with horizontal planting and control (without sett treatment) is because of the inferior growth attributes viz., plant height, number of leaves, number of tillers and leaf : stem ratio which was reflected in less dry matter accumulation and thereby lower amount of crude protein yield.

### 3.7 Nutrient Uptake (kg ha\(^{-1}\) cut\(^{-1}\))

The impact of planting methods and sett treatments on nutrient uptake (Fig.1) revealed that both had significant influence on nutrient uptake. Whereas interaction effect of planting methods and sett treatments had non-significant influence on nutrient uptake.

### 3.8 Nitrogen Uptake (kg ha\(^{-1}\) cut\(^{-1}\))

The results showed that nitrogen uptake was significantly superior under vertical planting (M1) which recorded 151.0 kg ha\(^{-1}\) cut\(^{-1}\). This was mainly due to the fact that the vertical planting was associated with greater above ground biomass and better root mass which in turn increased the nutrient uptake. This claim was supported by the findings of Howeler [27]. Whereas, lower nitrogen uptake of 142.7 kg ha\(^{-1}\) cut\(^{-1}\) was registered with horizontal planting (M2). Among sett treatments, water treatment (12 hours soaking and 24 hours incubation) (S1) recorded higher nitrogen uptake of 186.8 kg ha\(^{-1}\) cut\(^{-1}\). This superiority can be attributed to rapid sprouting and establishment, the best survival, high ground green cover and consequently the efficient use of light and soil moisture. This in turn increased the nitrogen uptake [28]. It was further comparable with beejamaruth (Concentrated solution) (S7) which recorded 181.3 kg ha\(^{-1}\) cut\(^{-1}\). The lower nitrogen uptake of 97.9 kg ha\(^{-1}\) cut\(^{-1}\) was observed with control (without sett treatment) which was on par with water soaking for 30 minutes (S2) with nitrogen uptake of 110.2 kg ha\(^{-1}\) cut\(^{-1}\).

### 3.9 Phosphorus Uptake (kg ha\(^{-1}\) cut\(^{-1}\))

Results for phosphorus uptake showed that, for planting methods vertical planting (M1) registered significantly, the highest phosphorus uptake of 23.4 kg ha\(^{-1}\) cut\(^{-1}\). This is because of the fact that their shoots sprouted earlier and produce more photosynthesize for the developing roots this in turn increased the phosphorus uptake. Lower phosphorus uptake of 21.6 kg ha\(^{-1}\) cut\(^{-1}\) was
recorded with horizontal planting ($M_3$). Higher phosphorus uptake of 31.9 kg ha$^{-1}$ was observed with water treatment (12 hours soaking and 24 hours incubation) ($S_1$). This might be due to higher earlier sprouting and growth, which might improve the plant capability for nutrient uptake from the soil [29]. This was at par with beejamruth (Concentrated solution) ($S_7$) which recorded 29.9 kg ha$^{-1}$ cut$^{-1}$. This might be due to phytohormones and beneficial microorganisms present in the beejamruth enhanced the root mass thus enhanced the nutrient uptake. Setts treated with beejamruth increases the bioavailability of nutrient in the root zone. Microbial release of nutrient enhanced the nutrient concentration in soil hence more uptake by plants [30]. The lowest phosphorus uptake of 11.4 kg ha$^{-1}$ cut$^{-1}$ was registered with control (without sett treatment) which was at par with water soaking for 30 minutes ($S_2$) with phosphorus uptake of 13.1 kg ha$^{-1}$ cut$^{-1}$.

3.10 Potassium Uptake (kg ha$^{-1}$ cut$^{-1}$)

Potassium uptake was significantly superior under vertical planting ($M_1$) which recorded 87.7 kg ha$^{-1}$ cut$^{-1}$. It might be because of the fact that vertically planted cuttings produced new shoots on a longer period than horizontally planted cuttings due to the early resource acquisition of sprouting buds which are permanently exposed to light. Plants might allocate more resources to continuous shoot production when exposed to sunlight as a competitive strategy, as long as they are not too shaded which ultimately increase the nutrient uptake [27]. The reason might also be the fact that, vertical planting enables the planting material to be established as early as possible and start the absorption of water which resulted in better growth and development. Therefore, the vertical planting registered the highest potassium uptake. Whereas, horizontal planting take more time for their establishment hence absorption of water and nutrient gets delayed, which in turn results in less quantity of NPK in plant [22]. The lower potassium uptake of 84.1 kg ha$^{-1}$ cut$^{-1}$ was observed with horizontal planting ($M_3$).

Among the sett treatments, water treatment (12 hours soaking and 24 hours incubation) ($S_1$) registered higher potassium uptake of 108.4 kg ha$^{-1}$ cut$^{-1}$. This might be attributed due to early establishment of roots, which absorb applied nutrients from soil immediately after planting and in turn increased the K concentration and dry matter accumulation ultimately higher uptake [31]. It was further comparable with beejamruth (Concentrated solution) ($S_7$) which recorded 102.6 kg ha$^{-1}$ cut$^{-1}$. The lower potassium uptake of 66.7 kg ha$^{-1}$ cut$^{-1}$ was observed with control (without sett treatment) ($S_{13}$), which was at par with water soaking for 30 minutes ($S_2$) which recorded 71.9 kg ha$^{-1}$ cut$^{-1}$.

3.11 Economics

The results obtained for economics viz., cost of cultivation, gross return, net return and benefit cost ratio of the study are given in the Tables 3 & 4.

3.12 Cost of Cultivation ($\text{\$ ha}^{-1}\text{cut}^{-1}$)

For planting methods, the higher cost of cultivation $\text{\$ 661 ha}^{-1}\text{cut}^{-1}$ was registered with horizontal planting ($M_3$). This mainly because horizontal planting require more time to plant which in turn increases the overall cost associate with planting [32]. Lower cost of cultivation of $\text{\$ 629 ha}^{-1}\text{cut}^{-1}$ was incurred with vertical planting ($M_1$). This might be due to vertical intrusion in the soil take lesser time when compared with horizontal planting [33]. Regarding sett treatments, the higher cost of cultivation of $\text{\$ 804 ha}^{-1}\text{cut}^{-1}$ was obtained with panchagavya (5%) ($S_6$). This was owing to the high cost involved in panchagavya preparation. Lower cost of cultivation of $\text{\$ 563 ha}^{-1}\text{cut}^{-1}$ was registered with control (without sett treatment) ($S_{13}$). In combination, highest cost of cultivation of $\text{\$ 817 ha}^{-1}\text{cut}^{-1}$ was incurred with the treatment horizontal planting with panchagavya (5%) treatment ($M_2S_6$). The lowest cost of cultivation of $\text{\$ 550 ha}^{-1}\text{cut}^{-1}$ was registered by vertical planting with water treatment (12 hours soaking and 24 hours incubation) ($M_1S_1$).

3.13 Gross Return ($\text{\$ ha}^{-1}\text{cut}^{-1}$)

With regarded to planting methods, higher gross return of $\text{\$ 1227 ha}^{-1}\text{cut}^{-1}$ was recorded with vertical planting ($M_1$) but lower gross return of $\text{\$ 1083 ha}^{-1}\text{cut}^{-1}$ was registered with horizontal planting ($M_3$). For sett treatments, maximum gross return of $\text{\$ 1698 ha}^{-1}\text{cut}^{-1}$ was registered with water treatment (12 hours soaking and 24 hours incubation). Lower gross return of $\text{\$ 721 ha}^{-1}\text{cut}^{-1}$ was observed with control (without sett treatment) ($S_{13}$). Interaction effect during the study showed that the maximum gross return of $\text{\$ 1777 ha}^{-1}\text{cut}^{-1}$ was recorded by the treatment vertical planting with water treatment (12 hours soaking and 24 hours incubation) ($M_1S_1$). The
minimum gross return of $705 ha$^{-1}$cut$^{-1}$ was
registered by horizontal planting with control
(without sett treatment) (M$^{-2}$S$^{-13}$). The higher gross
return registered with vertical planting with water
treatment (12 hours soaking and 24 hours
incubation) might be due to higher sprouting and
establishment percentage of vertical planting with
water treatment combined with higher green
fodder yield [26]. These results are in agreement
with findings of Shukla et al. [34] who reported
that treated setts establish earlier which produce
higher root mass which improved the vegetative
growth results in higher green and dry fodder
yield thus increases the economic returns.

3.14 Net Return ($ha^{-1} cut^{-1}$)
The higher net return of $598 ha^{-1} cut^{-1}$ was
registered with vertical planting (M$^{-1}$). Whereas,
lower net return of $428 ha^{-1} cut^{-1}$ was
recorded with horizontal planting (M$^{-2}$).
For sett treatments, water treatment
(12 hours soaking and 24 hours incubation) (S$^{-1}$)
registered maximum net return of $1135
ha^{-1} cut^{-1}$. Lower net return of $135 ha^{-1} cut^{-1}$ was
observed with ethrel (100 ppm) (S$^{-12}$). In
combination, vertical planting with water
treatment (12 hours soaking and 24
hours incubation) (M$^{-1}$S$^{-1}$) registered higher net
return of $1228 ha^{-1} cut^{-1}$. The might be
due to earlier sprouting induce root system
very rapidly that will increases the nutrient
uptake which in turn improve the growth, green
and dry fodder yield this leads to higher
economic value and net return [35]. Lower net
return of $130 ha^{-1} cut^{-1}$ was recorded with
horizontal planting with control (without sett
treatment) (M$^{-2}$S$^{-13}$).

3.15 Benefit Cost Ratio (B: C)
For planting methods, higher B:C of 1.98 was
recorded with vertical planting (M$^{-1}$). Lower B:C of
1.68 was registered with horizontal planting (M$^{-2}$).
Regarding sett treatments, water treatment (12
hours soaking and 24 hours incubation) (S$^{-1}$)

![Fig. 1. Effect of sett treatments and planting methods on nutrient uptake (kg ha$^{-1}$ cut$^{-1}$) of B.N. hybrid grass](image-url)

Fig. 1. Effect of sett treatments and planting methods on nutrient uptake (kg ha$^{-1}$ cut$^{-1}$) of B.N. hybrid grass

$M_1$ - Vertical planting, $M_2$ - Horizontal planting, $S_1$ - water soaking for 12 hour and 24 hours incubation, $S_2$ - water soaking for 30 minutes, $S_3$ - hot water soaking at 40°C for 20 minutes, $S_4$ - cowdung slurry (1:1) soaking for 30 minutes, $S_5$ - panchagavya (3%) soaking for 30 minutes, $S_6$ - panchagavya (5%) soaking for 30 minutes, $S_7$ - beejamruth soaking concentrated solution for 30 minutes, $S_8$ - beejamruth (50% dilution) soaking for 30 minutes, $S_9$ - GA3 (5 ppm) soaking for 15 minutes, $S_{10}$ - GA3 (10 ppm) soaking for 15 minutes, $S_{11}$ - ethrel (50 ppm) soaking for 15 minutes, $S_{12}$ - ethrel (100 ppm) soaking for 15 minutes, $S_{13}$ - control (without sett treatment)
recorded higher B:C of 3.02. Lower B:C of 1.18 was registered with ethrel (100 ppm) (S12). In interaction higher B:C ratio of 3.23 was registered with vertical planting with water treatment (12 hours soaking and 24 hours incubation) (M1S1). Lower B:C ratio of 1.17 was recorded with horizontal planting with ethrel (100 ppm) (M2S12) treatment. The impact of increased growth and yield attributes produced higher biomass yield [36] and in turn resulted in higher net return and B: C ratio [34].

4. CONCLUSION

Based on the results, it can be concluded that planting methods and sett treatments had significantly increased the nutrient uptake and crude protein yield. However the quality parameters viz., crude protein content, crude fibre content, crude fat content and total ash content had no significant influence neither by planting methods and sett treatments or the interaction effect between them. This study also concluded that for achieving better nutrient uptake, crude protein yield, higher net return, gross return, benefit cost ratio and reduced cost of cultivation, vertical planting with water soaking for 12 hours and 24 hours incubation is the best practice for bajra napier hybrid grass CO (BN) 5.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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