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Planting Methods and Number of Buds of Setts on Sprouting, Growth and Productivity of Vegetative Propagated Crops: A Review

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ABSTRACT

Ever increasing demand for food and fodder due to growing population and livestock necessitates the urgency to improve productivity of the fodder crops. In this context, the concept of vegetative propagation technologies serves as an important tool for higher productivity. Conventionally, crops such as sugarcane, cassava, *bajra* napier hybrid grass and napier grass were cultivated by stem cuttings. This depends heavily on the quality of planting material and their availability. It is a huge barrier for the cultivation of fodder grass as the quality of planting material influences the sprouting, establishment, growth, tillering and fodder yield of grasses and also the higher requirement of planting material increases the overall cost of cultivation. Therefore, a more robust approach needs to be developed to address these limitations. Normally propagation by vegetative means assumes importance when desirable biotypes need to be multiplied in a short span of time. Also a suitable method of planting and number of buds reduce the cost of cultivation as well as transportation. Similarly one and two budded setts are ideal for optimum germination compared to larger seed pieces. Horizontal planting of stem cuttings is the most practical approach which increased sprouting and yield. Based on this ideology this paper reviews the various aspects of influence of planting methods and number of buds by vegetative propagated setts on sprouting, growth and productivity of fodder grasses.

Key words: Fodder grass, Fodder productivity, Number of buds, Planting methods, Stem cuttings.

Vegetative propagation of plant is a form of plant propagation in which the new individual plant arises from any vegetative part of the parents (root, stem, leaf and other organs) and possesses exactly the same characteristics of their parent plant from which it was obtained. Vegetative propagation of plant is a form of plant propagation in which the new individual plant arises from any vegetative part of parents (root, stem, leaf and other organs) and posses exactly the same characteristics of their parent plant (Megersa, 2017). Conventionally crops such as sugarcane, cassava, *bajra* napier hybrid grass and napier grass mainly propagated through stem cuttings (Singh *et al.,* 2011). But this method of cultivation have some major constraints, such as, high transportation cost due to high volume, damage to the standing crop from where rooted slips are taken out, involvement of high labour cost, *etc.* (Vijay *et al.,* 2018). Similarly the requirement of large amount of planting material poses a huge problem in transport, handling and storage of sett material and undergoes rapid deterioration thus reducing the viability of buds andsubsequently their sprouting. One alternative to reduce the mass and improve the quality of sett is reducing sett size with sett treatment (Jain *et al.,* 2010). Further several studies have found that the planting methods also has a significant influence in the crop yield.

Further on this context it is also identified that the planting of two node stem cuttings vertically in ridges gave lower germination due to physical injury to the buds in the bottom of the stem while planting (Jayanthi, 2007). Whereas, planting two node stem cutting horizontally was found advantageous and registering the higher green forage yield (Fazlullah Khan *et al.,* 2000). Therefore it can be established that using a suitable planting method we can reduce the amount of inputs and further improve the efficiency and productivity of the crops. In this view this article is explores the importance of vegetative propagation on planting methods and number methods on sprouting, growth and productivity of crops.

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Effect of planting methods on growth and productivity of vegetative propagated crops

Planting methods on sprouting and establishment

A study conducted by Castro (1979) revealed that the maximum germination percent (100%) was recorded with vertically planted setts and it also reduced the lodging.

Ssekabembe (1998) in his findings observed that erect planting method resulted in slightly higher sprouting per cent of napier cuttings, further study by their research reveal that planting methods will not show a notable difference over sprouting and plant survival. Oguzor (2007) conducted a field study to evaluate the effect of planting methods. In his finding among the different planting methods, vertical planting recoded higher sprouting per cent (88.8%) when compared with slanting and horizontal planting.

A field experiment, conducted by Jayanthi *et al.* (1999), showed that planting of 3-4 feet stems cutting of *bajra* napier hybrid grass buried in furrow had higher germination percent than other planting methods and this might be due to more number of nodes present in the stem cutting led to higher germination. But, findings of Viana *et al.* (2000) revealed that planting of vertical or inclined position of cassava stem cuttings registered higher emergence per cent.

Martinho *et al*. (2010) concluded in their findings that, 0° and 90° position showed best results for germination and stalk height at 125 days after sowing. They also observed that 180° and 270° position of bud shows delayed germination and less stalk height, but reported that the position of bud does not affect the diameter of stalk as well as final yield significantly. Knoll and Anderson (2012) reported that, under green house management showed germination rates of 57.5% to 100% for horizontally buried setts and 85% to 97.5% for vertically planted setts. Similarly, a field experiment was conducted by Nithya *et al.* (2017) revealed that, planting rooted slips vertically produced significantly higher number of sprouting (95.3%) and establishment (100%).

Planting methods on growth and yields

A study conducted by Singh and Kumar (1977) revealed that vertical planting increased the cane yield when compared with horizontal planting of sugarcane under late planted condition in North India. But planting of germinated setts horizontally produced the same cane yield as in vertical planting. Similar study by Panje (1971) also confirmed this by concluding that, vertically planted setts produced significantly higher yield of 59.6 m.t/ha was reported.

Takyi (1974) found that flat planting of setts significantly improved the yield (5.5%) over slant partial burying. Generally flat planting tends to delay sprouting by few days but this delay did not appear to affect yield at harvest. Castro (1979) also expressed this and found that planting cassava setts vertically showed higher total (31.1 t/ha) and commercial (27.4 t/ha) yield when compared with inclined and horizontal planted setts.

From their research Ezumah and Okibo (1980) found that, planting of cassava in slanted position showed better root yield and significant increment in leaf yield and number of stems per plant as well horizontally planted setts of cassava reduced the lodging compared with those planted in an inclined or vertical position. Gordo (1984) also found that, vertical planting recorded 50 roots whereas, horizontal planting produced only 30 roots in cassava. However, vertical planting reached the maximum root production (55 roots) within 2 month after planting whereas, horizontal planting reached the maximum (75 roots) one month later with a margin of 36 per cent increase over vertical planting. The vertical planting also recorded higher number of leaves than horizontal panting on both monthly and yearly basis. Tongglum *et al*. (1987) noticed that vertical planting of cassava registered higher fresh root yield (30.75 t/ha) when compared with inclined and horizontal planting.

But, Okogbenin *et al*. (1999) studied different planting methods such as horizontal planting in furrow or ridge, vertical planting on flat or ridge and inclined planting on flat or ridge on cassava performance. They observed horizontal planting at the ridges showed taller plants (114 cm). Whereas, inclined and vertical planting flat/furrow method significantly reduced the plant height.

A field experiment conducted by Fazlullah Khan *et al.* (2000) revealed that, horizontal planting of two budded stem cuttings of bajra napier hybrid grass recorded higher green fodder yield of 221 t/ha/year when compared with vertical planting of two budded stem cuttings which registered lower green fodder yield of 152 t/ha/year. Bajra napier planted on furrow and buried gave the higher green fodder yield of 375.3 t/ha/year while the lower green fodder yield was recorded when the two nodal stem cuttings planted vertically in ridges was reported by Jayanthi (2003).

A study by Premaratne and Premalal (2006) reveal that, rooted slips planted vertically or stem-cuttings planted horizontally at 90 cm × 60 cm or 90 cm × 90 cm showed significantly higher green forage yield. Similarly, Oguzor (2007) found that, taller plants were observed with horizontal planting at 20, 40 and 60 days after planting with 48, 125.3 and 201.6 cm plant height. Shorter plant height was observed with vertical planting.

A further research by Mbah *et al.* (2008) showed that planting of cassava in a slanting position (45° position) gave the lowest total number of tubers per plant (7.84) but increased the weight of tubers per plant and fresh tuber yield per ha (21.25 t/ha). The reduction in yield when cassava planted horizontally (180° position) could be attributed due to increased number of shoots per plant, resulting in competition for growth, resources as well as diversion of photosynthesis into tissues for stem and internodes elongation due to mutual shading by the shoots.

A study to evaluate the impact of planting position on root yield of cassava by Legese *et al*. (2011) resulted that higher harvest index (0.38), root yield (20.7 t/ha) and the highest biomass yield (22.9 t/ha) were recorded with slanting position of cassava planting and the lower harvest index and root yield was associated with horizontal planting. Whereas, higher stems per hill (2.9) was recorded in horizontal planting of cassava and this was followed by slanting and vertical planting.

Knoll and Anderson (2012) in their study reported that, a higher number of shoots per cutting of 2.5 were recorded with the vertically planted setts than horizontal planted setts.

Further greater root mass (2.84 g) and root length (42 cm) were also recorded with vertical planting over the horizontally planted cuttings. The lower values of root mass and root length of 2.13 g, 37.6 cm were registered with vertical planting was reported in napier grass.

A field experiment by Pathan Sarfrajkhan (2013) revealed that planting rooted slips in slanting position at 90 cm × 60 cm recorded higher plant height of 182.2 cm, number of leaves per bunch (485.1), number of tillers per bunch (55), leaf: stem ratio (1.14), total green forage yield (267.67 t/ha) and total dry matter yield (53.07 t/ha) when compared with horizontal planting of one and two eye budded setts. Similarly, Abdullahi *et al.* (2014) from their study concluded that, vertical planting showed the maximum leaf area index of 3.73 per plant. But inclined planting of cassava recorded higher root yield of 20.12 to 32.99 t/ha.

Horizontal planting of cassava setts recorded higher root number, root length and root dry weight when compared to the vertical planting was reported by Polthanee and Bamrungrai (2016). This was further supported by Haegele *et al*. (2017) who reported that horizontal burying of setts tend to double the dry matter yield as this planting method placed double the number of buds in the ground compared to vertical insertion. But, Haegele and Arjharn (2017) contradict this by stating that there was no significant difference between planting methods of setts during their study.

A similar field experiment conducted by Polthanee and Wongpichet (2017) revealed that vertical planting produce higher number of storage root per plant (10.7) and fresh storage root yield (60.6 t/ha) when compared with horizontal planting of cassava which recorded lower number of storage root per plant (8.9) and fresh storage root yield (54.3 t/ha).

Planting methods on quality

Jayanthi *et al*. (1999) in their study stated that, no significant difference was observed with crude protein yield (t/ha/year) between different planting methods. But, Pathan *et al.* (2012) stated that planting rooted slips in slanting position at (90 cm × 60 cm) recorded higher total crude protein yield (35.30 q/ha), total crude fibre yield (164.15 q/ha) when compared with horizontal planting of one and two eye budded setts. But he also observed no significant difference among average crude protein content, crude fibre content and ash content (%).

A field experiment conducted by Pathan *et al*. (2014) found that no significant differences were observed in crude protein content and crude fibre content of slanting and horizontal planting method. Further an experiment conducted by Senthil *et al*. (2016) revealed that planting at slanting position of bajra napier hybrid grass (CO-3) recorded higher total ash content (14.3%) and ether extract (3.11%).

A study conducted by Ishrath *et al*. (2018) to study the effect of cutting intervals on yield and quality fodder production revealed that, planting by slanting position with 45 days cutting interval recorded higher crude protein content (10.56%) and lower crude fibre (26.81%) when compared to other cutting intervals.

Planting methods on economics

A field study was conducted by Jayanthi *et al.* (1999) reported that planting of 3-4 feet long stem cuttings in furrow and buried with the basal application of 100% recommended dose of N, P_2O_5, K_2O fertilizer gave higher net return of ₹ 96, 931/ha and B:C ratio (5.18) in *bajra* napier hybrid grass (CO-3).

In their study Pathan *et al.* (2014) stated that, rooted slips planting in a slanting position at (90 cm × 60 cm) registered higher gross returns (₹ 1,47,200/ha) with higher cost of cultivation (₹ 75, 400/ha). Whereas, net return (₹ 77,200/ha) and B:C ratio (2.4) were high with horizontal planting at (90 cm × 30 cm) of one eye bud sett. A similar findings was also reported by Nithya (2016), who revealed planting of rooted slips in slanting position recorded higher gross return (₹ 2,79,870/ha), net return (₹1,79,228/ha) and B:C ratio (2.8). But, Alagudurai (2014) conclude that, planting of two budded stem cuttings on slanting position registered higher gross return (₹ 4,43,804/ha).

Number of buds on growth and productivity of vegetative propagated crops

Number of buds on sprouting and establishment

Higher germination per cent was obtained with single budded setts with rapid germination, but subsequent plant growth was less vigorous was stated by Pao and Shiah (1960). In a similar experiment observations made by Panje *et al*. (1972) showed that higher clump number and germination are associated with single budded setts. Comparatively three budded setts had lesser number of clumps. Further, Jothimoorthy *et al*. (1980) also recorded higher per cent of germination in direct planted single budded setts than two and three budded setts. Similarly, Goodall *et al.* (1998) also found that single budded setts treated with hot water at 52°C for 10 minutes significantly increased the germination per cent. In their study Pawar *et al.* (2005) also reported that significantly higher germination per cent (96-98 per cent) was recorded in single budded ploy bag settling as compared to two budded sett planting.

But, reports by various AICRP centres of sub-tropical and tropical regions around the country revealed that, two budded setts has a distinctive superiority over single budded setts in terms of germination and growth of sugarcane. Suryavanshi *et al*. (2010) revealed that planting of single budded setts recorded lower germination and establishment per cent with less vigour in sugarcane crop when compared to two and three budded setts. Similarly, Chitkala Devi *et al*. (2011) observed higher germination percent in sugarcane with three budded setts and two budded setts as compared to single budded setts.

Findings posted by Chand *et al*. (2011) stated that, higher germination per cent and growth was observed with two budded setts of sugarcane when compared with single budded setts. This claim was supported by the findings of

Yadav (1992) and Singh *et al*. (2008) who found that germination was superior in three and two budded setts when compared to single budded setts of cane.

In a similar study, Rahman (2012) recorded significantly higher germination per cent in single budded sett planting as compared to two budded sett planting. Liang *et al.* (2018) found that single seedcane setts with 4 cm long premis coating increased the germination per cent. This was further supported by the findings of Sugeerthi *et al.* (2018) and Khaing *et al.* (2018).

Jayesh Singh *et al*. (2013) revealed that higher germination per cent was recorded with two budded setts sugarcane than three and one budded setts. Mohanty (2016) revealed that planting more than one budded setts record higher germination per cent followed by planting primed and sprouted single budded cane setts at 40 DAP. Tesfa and Ayele (2018) found that planting three budded setts recorded higher sprouting per cent (73.67%) when compared with one budded setts (70.55%). There are enough evidence to say that both single and double budded setts has their own advantage and disadvantage based on the conditions they used. Although the double budded was considered as an effective option, the cost effectiveness of single budded setts are its vital dominant factor over the double budded setts.

Number of buds on growth and yields

Planting of two budded setts registered narrow tuber per shoot ratio than single budded setts and multi-shooted plants (Shanmugam and Srinivasan, 1973). Whereas, Linga Reddy (1982) observed that higher cane weight and cane girth of sugarcane were recorded with single budded setts when compared with two and three budded setts. Imam *et al*. (1982) conducted an experiment at the SRTI farm in 1980-81 to assess the potential of transplanting of single eye germinated bud (TSEGB) with conventional early planting, late planting and single bud direct planting of sugarcane setts. Results indicated that transplanting of single eye germinated bud produced statistically identical yield to that of conventional early planting with three eyed setts. But, Yadav (1992) contradicted this by their findings that two budded setts has a notably higher plant height and growth parameters over the results of single budded setts.

Single budded setts have 11 per cent increase in cane yield and 34 per cent heavier individual stalks than compared to double budded setts was reported by Tianco (1995). Planting of single bud setts recorded significantly higher cane height, cane girth, number of inter nodes per cane, individual cane weight and dry matter production per plant than micro propagated plant and ratoon canes (Raskar and Bhoi, 2003). Patel *et al*. (2009) in their research concluded that planting of single budded setts with above 2.5 cm and below 7.5 cm of cane resulted in higher cane yield of 93.26 t/ha when compared with planting of two budded setts.

A study was carried out by Chitkala Devi *et al*. (2011) over the effect of sett size on yield and quality of sugarcane. Their findings concluded that planting of two budded setts produced higher number of millable canes (₹ 79122/ha) than the one budded setts (₹ 69299/ha). Chand *et al*. (2011) further posted similar findings that planting with two budded setts recorded higher number of millable canes (113800/ha) over single budded setts in sugarcane (₹ 65000/ha). The trail further revealed that two budded setts in comparison with one budded sett showed superiority in terms cane height and cane girth.

Planting of two budded setts gave significantly higher number of tillers (₹ 104000/ha), cane length (167.2 cm) and cane yield when compared to single budded setts which recorded lesser number of tillers (₹ 69000/ha), cane length (159.5 cm) and cane yield (Jayesh Singh *et al*., 2013). It is evident from the findings of Yadav *et al*. (2013) that three budded setts is comparable with two budded setts in terms of attaining number of millable canes and cane girth, but single budded setts have relatively lower number of millable canes and cane girth than the others. Similar experiment was conducted by Bhanupriya *et al*. (2014) further explored the findings Yadav *et al*. (2013) by concluding that two budded setts recorded higher leaf area index and tiller production (8.1 and 230000 nos./ha, respectively) in sugarcane than the single budded setts (7.7 and 223000 nos./ha, respectively).

Further, a field experiment by Mohanty (2016) to find the effect of planting primed single budded setts on yield and quality of sugarcane during 2012-13 and 2013-14 revealed that cane yield was higher with conventional three budded planting (₹ 86.23 t/ha) but was on par with primed single budded setts (₹ 83.85 t/ha). Liang *et al*. (2018) supported this by their claim that single budded setts with 4 cm long, stored for 3 days at 22°C with premis coating (setts coating agent) increased the plant height (4.5 m) stalk diameter (25.5) and single stalk weight (2.3 kg).

Number of buds on quality

A field study by Mohanty and Nayak (2011) report that sett size did not affect sucrose content. But, Pathan *et al.* (2012) revealed that, when compared with one and two eye budded setts, significant difference was observed in average crude protein content (%), crude fibre content (%) and ash (%). Further Pathan *et al.* (2014) also revealed that number of buds showed non-significant difference on fodder quality. Similarly Mohanty (2016) found that there was no significant difference between brix, pol, purity percent but three budded sett planting recorded superior values followed by priming of single budded setts. Tesfa and Ayele (2018) reported that there was significant influence of numbers of buds on the sucrose content of the cane.

Number of buds on economics

In their study Singh *et al*. (2009) stated that planting of three budded setts significantly increased net return (₹ 93,500/ha) of sugarcane. But Chand *et al*. (2011) revealed that planting of single budded settlings followed by two budded setts of sugarcane registered higher net retunes and benefit cost ratio. Similarly Alagudurai (2014) also revealed that planting of two budded stem cuttings registered higher gross return

(₹ 4,43,804/ha) on bajranapier hybrid grass. On a similar context, a field experiment was conducted at sugarcane research station, cuddalore during special season of 2017 - 18 (July - February) to evaluate different sugarcane planting materials on economics. The results showed that, chip bud seedlings planting registered the maximum economic returns in terms of net income (₹ 1,83,040/ha) and B:C ratio of 2.63 (Sugeerthi *et al*., 2018).

CONCLUSION

It can be established based on the evidence presented in this review that a suitable method of planting and number of buds considerably reduces the cost of cultivation and transportation cost, one of the major barrier in the cultivation. Further it can also said that one and two budded setts are the ideal planting method for achieving optimum germination. Further theplanting the setts horizontally of stem cuttings is the most practical approach for achieving higher sprouting and yield. With this it can be concluded that the planting method will have a significant impact on the cultivation of crops and planting of one and two budded setts in a horizontal planting will have a considerable advantage over other methods. By doing so the most prominent limitations in the cultivation of crops such as sugarcane, cassava, bajra napier hybrid grass and napier grass will be addressed and thereby the efficiency and profitability of these crops as increase the interest among the farmers for the cultivation of these crops.

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