EFFECT OF SOWING METHODS ON GROWTH AND FODDER YIELDS OF SWITCH GRASS (*Panicum virgatum* I.) IN KEBBI STATE UNIVERSITY, KEBBI, NIGERIA

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ABSTRACT

A field trial was conducted during the 2012/2014 rainy season at Jega Teaching and Research Fadama farm of Kebbi State University of Science and Technology. This work was aimed to investigate the effect of sowing methods on growth and fodder yields of switch grass (Panicum virgatum I.) at Kebbi State University of Science and Technology, Teaching and Research Farm, Jega, Kebbi State. Due to insufficiency of all year round grazeable forage for livestock, owing to seasonal changes is still a major constraint to livestock production in semi-arid zone of Nigeria. As a result of this establishment fact, the bulk of indigenous cattle, sheep and goat of the area have for long subsisted on bush grazing of natural pastured of low nutritive value found in the savannah lands. These animals in consequence grow slowly, produce small milk and reproduce at long intervals. These however, subject farmers to realization of heavy economics losses.Treatments consisted of three sowing methods (dibbling, drilling and broadcasting) laid out in a Randomized Complete Block Design (RCBD) replicated three times. The observations were; stand establishment count, plant height, leaf length, leaf width and number of leaves/plant. The herbage yield of the plant was also measured. The mean establishment stand was observe not to be significant (P≤0.05) for sowing methods, there was also significant influence of sowing methods on the leaf width in all levels of sampling. The leaf length and herbage yield were also recorded to be significant (P≤0.05) at all levels of the treatments. Number of leaves/plant was recorded not to be significantly affected (P≤0.05) by the sowing methods. Both the growth components and herbage yield were observed to be more significant (P≤0.05) for dibbling than drilling and broadcasting sowing methods. Thus, from the finding of this research it could be concluded that dibbling sowing method is recommended to be used for increased fodder production of switch grass in semi-arid Kebbi State. This work would serve as the background for subsequent researches in the future.

Keywords: Effect, fodder yields, sowing methods, switch grass.

INTRODUCTION

Switch grass (*Panicum virgatum* L.) is a perennial warm-season grass (belonging to family Poaceae) that resembles bunch grass; it spreads slowly by seeds and numerous scaly creeping rhizomes. The plant has erect stem that can be between 0.5 and 2.7m tall and often have a reddish tint. The inflorescence is an open panicle 15-50cm long, it is pyramid shaped with many purplish spikelet. The root system can be up to 3m deep. The leaves has a bluish cast and can attain the length of 2ft. at the junction of the leaf blade and the leaf sheath, the ligule is a dense ring or cup of hairs in the upper leaf surface (Iwuanyanwu *et al.,* 2012).
P. virgatum is one of the dominant species of the central North American tall grass prairies, where it occurs naturally from 55N in Canada, United State and Mexico. Abdullahi *et al* (2013), reported that switch grass is primarily for forage production, soil conservation and game cover, as ornamental grass and more recently as biofuel crop. Switch grass has two major ecotype or varieties; the lowland and upland, which vary widely in their adaptation to environmental conditions. Cold winters, hot summer and day length are the most important of this environmental factors all of which vary according to latitude (John *et al.,* 2008). Switch grass will grow best on well drained quality soils, but will also sustain lower quality acidic soils. Most switch grass ecotypes can tolerate shorter period of water logging, but the grass is generally not found when rainfall is below 300mm per year (NLA, 2013). Switch grass is adapted to poor soil fertility including soil with low level of potash, phosphorus and nitrogen

(Mohua *et al.,* 2012). Research has shown that pH has limited effect on switch grass yield. If switch grass is exclusively grown for hay, 4-5 tons per acre are not uncommon and two distinctive harvest are possible within a single growing season (Christensen and Gary, 2010).

Switch grass is well adapted to different soil types and climates. Although well drained soils with a neutral pH of 7.0 are preferred. It can also grow quite well on acid soils. Liming to increase soil pH is an alternative though may often not be cost effective. Also measures to reduce weed pressure by sowing a grain crop in the previous year and weed control measures can be used. Different varieties of switch grass are available and some new varieties were developed specifically for bioenergy recently. The origin of a variety is very important as it gives an indication of the range of the variety adaptation.

Generally switch grass varieties grown too far north (from the latitude of origin) will not flower or will flower later and will not mature before onset of winter. This will lead to relative high yields in the first growing season but it will also lead to winter damage of the stand and less re-growth in spring. This will reduce yield in the subsequent and following years. It can also lead to low stand maintenance over time. Later maturing varieties will also have higher moisture contents when harvested leading to higher storage and drying cost. Later maturing varieties will also have higher nutrient contents which lead to lower quality (for combustion) and increased the cost of fertilization.

Forage quality of Switch grass is similar to most native, warm-season C_4 photosynthetic grasses. It quality mostly depend on maturity and it is vegetative during spring, switch grass has 10-15 crude protein and about 70% digestible dry matter. By mid-summer, it elongating crude protein and dry matter digestibility drops to about 8 and 60% respectively. Like most other native grasses, switch grass can provide good summer forage for beef cattle and if manage correctly, it is used for either grazing or hay production. Switch grass should not be fed to other livestock such as horses, goats and sheep as it contain chemical compounds called saponin, that cause severe health problems (Christensen and Gary, 2010).

Three sowing methods are conveniently used for forage establishment. These are broadcasting, dibbling and drilling depending on the forage materials, size of the land area and funding from the farmer. Broadcasting is employed when the seed drills are unavailable or when the ground is too soft to allow the use of machinery (Casler *et al.,* 2012). A range of sowing methods and machinery are used for sowing forages, in many cases, the sowing method is a compromise between agronomic desirability, practicality and the desire to minimize establishment cost (Cook *et al.,* 1993). The most important process in the establishment of forage cereals is the amount of seeds which germinate and emerges and the number of seedlings which survive and develop into mature plants (Lowe and Boudler, 1991).

The amount and the distribution of rainfall following sowing have a major influence on the outcome of these processes (McKeon and Brook, 1983). Broadcasting small grains on freshly tilled soil and lightly covering the seed with soil cause random seeding depth and typically does not firm the soil around the seeds. The result normally is less seed emergence success (60-70% plant seeds) than with drilled (McKeon and Brook, 1985). Switch grass may be established by seeds at seedling rate of 5.6 kg/ha of pure live seed (PLS), with up to 11.2 kg/ha applied to sites with poorer growing condition and as low as 2.2 kg/ha under ideal condition (Christensen and Gary, 2010). Some studies suggest that higher planting rates of up to 9 kg/ha even in situation where low rate are sufficient to establish a stand, have a net positive economic return because the value of the extra biomass more than compensate for the slightly higher planting cost.

To ensure good plant stands, switch grass is best sown drilled or broadcast in a cultivated seed depth of 12.7 mm in a fine soil or 19 mm in the coarse soils. However, current studies across multiple locations and seasons suggest that standard establishment and seedling vigour can be improved by planting at a deeper depth of 12.7-19 mm in fine soils or up to 25 mm in coarse soils (Christensen and Gary, 2010).

The insufficiency of all year round grazeable forage for domestic animals, owing to seasonal changes is still a major problem to livestock production in semi-arid zone of Nigeria (Babayemi *et al.,* 2006). As a result of this establishment fact, the bulk of indigenous animals like cattle, sheep and goat of the semi-arid environment have for long subsisted on bush grazing of natural pastured of low nutritive value and not always available for the livestock to feed in the savannah lands. These animals in consequence grow slowly, produce small milk and reproduce at long intervals (Oyenuga and Olubajo, 1975). These however, subject farmers to realization of heavy economics losses. Further, since ruminant production is mostly carried out by small holder farmers and has great potentials in the semi-arid zone of Nigeria (ILCA, 1982), reliance on natural pastures that provide the most cheapest source of nutrients for ruminant has resulted in failure to meet the nutritional needs of livestock throughout the year (Bello, 2012). In attempt to correct some of these obstacles to ruminant production in fragile environments like that of the arid and semi-arid regions of Nigeria, manifold of research works suggest that farmers should diversify their production system by integrating value sown pasture crops (Casler *et al.,* 2012). Since one or more species of the grass forms a major component of the natural vegetation that serves as the grazing resources to ruminants in the area (Onayinka and Akinyemi, 1976). Growing and developing perennial forage crops such as *Panicum virgatum* (switch grass) provide the farmer with available grazing resources for meeting the nutritional requirement of the animal (Abdullah *et al.,* 2013), benefit national economy by providing an important new source of income to the farmers and government at large not only in Nigeria, but it can also be achieve in other countries like Malaysia, Thailand, South Africa, Kenya and Tanzania, It will also serve as a means of soil conservation (USDA and NRCS, 2008), and game cover. High value fodder crops like switch grass can be used for dry season supplementary feeding as silage (Amakirin *et al.,* 2011). Yield of 2-6 tons by acre can be expected depending on rainfall and the soil types as well as other environmental conditions. Nutrient content of switch grass can be as high as 16-17% crude protein if harvested correctly (John *et al*., 2008). Dale and David (2009) discovered that switch grass does well on a wide variety of soil types; it is drought tolerant (rainfall of 300mm and above) and produces well on shallow, rocky soil. Soil pH should be 5.0 or above and where soil

test indicate medium or higher P_20_5 and K_2O, no fertilization is needed at planting (Dale and David, 2009). This study focuses on the use of different sowing method of switch grass. Semi-arid region is an area with large number of farmers (rearing livestock). Therefore, green pasture is of significant importance in the area. Other countries like United State and Netherland are now using switch grass not only for fodder production but also for bioenergy. So far, no much information was reported on the use of switch grass in Malaysia due to lack of published materials. The present research was carried out in order to investigate the effect of different sowing methods on growth and fodder yields of switch grass (*Panicum virgatum I.*) at Kebbi State University of Science and Technology, Teaching and Research Farm, Jega Kebbi State.

MATERIALS AND METHODS

EXPERIMENTAL SITE

A field trial was conducted during 2013/2014 rainy season at Jega training and research farm of Kebbi State University of Science and Technology. Jega is located in the Sudan savannah agro-ecological zone of Nigeria on latitude 12°11 N; longitude 4°16 E; at an altitude of about 350 m above the sea level. The climate of the area is semi-arid with erratic and scanty rainfall (500-600 mm) that usually last for five months (May-September) and long dry period (October-April). The relative humidity ranges from 21-47% during dry Season and 51-79% during the rainy season. Temperature ranges from 14-30 °C and 27-41 °C during rainy and dry season, respectively.

TREATMENT AND EXPERIMENTAL DESIGN

The treatment consists of three sowing methods (broadcasting, dibbling and drilling). The treatments were laid out in a Randomized Complete Block Design (RCBD) replicated three times amongst three blocks.

FIELD LAYOUT

Gross plots measuring 2 m × 3 m (6 m^2) was demarcated, and 1 m × 1 m (1 m^2) was marked out as the net plot area. Three blocks laid in an east to west direction containing three plots measuring 1m × 1m with a total of 9 plots used.

CULTURAL PRACTICES

2.4.1. Land preparation and fertilizer application

The land was prepared manually using hand owing and plot measuring 1 m × 1 m was marked out in a Randomized Complete Block Design (RCBD) replicated three times. Plots were separated by 0.5 m (foot path), where as a distance of 1 m was maintained between blocks. NPK fertilizer at the rate of 100 kg/ha was applied as supplementary nutrient source at two weeks after planting.

PLANTING MATERIALS

Seeds of Switch grass (Alamo) obtained from United States of America (USA) through Sokoto State Energy Research Centre of Usman Danfodiyo University on Pure Live Seed (PLS) bases were used. Seeds were sown by direct seeding (manually) using seed rate of 5.6 kg/ha for all the treatments. Spacing of 30 cm (inter row) × 30 cm (intra row) and 50 cm apart at 0.5-1.0 cm planting depth was used for dibbling and drilling respectively. Seeds were evenly spread after raking for broadcasting method and were slightly covered.

WEEDING AND HARVESTING

Weeding commenced at two weeks after establishment and weeds were controlled manually using hand hoe after every two weeks and subsequently throughout the duration of the experiment. Harvesting was done manually, using a sharp sickle at 12 weeks after sowing (WAS). Plants were harvested at the height of 5 cm above the ground level.

GROWTH PARAMETERS

Plant establishment was obtained by counting all the plants from the net plots at two WAS and converted to percentage. Plant Height was recorded at two WAS, the height was measured from ground level to the tip of the tallest leaf of the 5 tagged plants using metre rule and repeated after every two weeks for the rest of the period of the experiment. Leaf Length was measured from five randomly selected plants within the net plots at 2 weeks interval from 2-12 WAS. The leaf length was obtained by measuring the leaf from the base of the leaf stalk to the tip using metre rule. The leaf width was measured from the five randomly selected plants within the net plots from 2 weeks to 12 weeks after sowing. This was done by measuring the widest portion of the leaf using metre rule. The numbers of leaf per plant from the five tagged plants were counted from the second WAS and then every two weeks for the period of the experiment. The herbage yield was taken by cutting the plants from 5 cm above the ground and was deduced from the net plot area, fresh yield was measured using weighing balance scaled in kg per m^2 which was later converted to kg/ha and air dried for two weeks to estimate the total dry matter yield (DM) yield in kg/ha.

DATA COLLECTION

Data were collected on stand establishment count, plant height, leaf number, leaf length, leaf width and herbage yield. Five plants were randomly sampled and tagged for measurement of all the growth parameters during the experimental period. The data collected were subjected to analysis of variance (ANOVA) using SAS (SAS Institute, Inc., Release 9.1 for windows). Least significance difference (LSD) was adopted for mean separation where significance difference was observed at $P \leq 0.05$.

RESULTS AND DISCUSSION

STANDARD ESTABLISHMENT COUNT

Standard establishment count of Switch grass as influenced by the sowing methods is presented in Table 1. Plots one and two were found to have the highest mean in term of standard establishment count with 60.67 each, while plot three was found to be the lowest with 58.33. Based on sowing methods, broadcasting method was found to have the highest mean with 62.33. Followed

by dibbling method having 59.00. Drilling method was having the lowest standard establishment count with 58.33. There was no significant effect (P ≤ 0.05) of sowing methods on standard establishment counts of Switch grass.

Table 1: Standard establishment count as affected by the sowing methods

Treatments	2WAS			
	PLT1	PLT2	PLT3	MEAN
Broadcasting	65	63	59	62.33a
Dibbling	59	60	58	59.00a
Drilling	58	59	58	58.33a
Mean	60.67	60.67	58.33	-

Means followed by the same letter(s) within the same treatments are statistically the same (p ≤0.05), WAS = Weeks after Sowing, PLT=Plot.

PLANT HEIGHT

The mean switch grass plant height as influenced by sowing methods during the field trial as presented in Table 2. The result revealed that the response of switch grass plant height to sowing methods were significantly different at (P≤0.05) after the tenth week of sowing across the treatments. Dibbling method was found to be the highest with mean of 78.33 cm, while drilling method was having 60.15 cm. Broadcasting method was found to be least with 53.01 cm.

Table 2: Standard plant height as affected by sowing methods

Treatments	2WAS Cm	4WAS Cm	6WAS Cm	8WAS Cm	10WAS Cm	MEAN
Broadcasting	24.53	54.43	64.40	60.18	61.53	53.01c
Dibbling	24.39	64.57	75.13	111.03	116.52	78.33a
Drilling	23.80	65.58	78.58	66.02	66.78	60.15b

Means followed by the same letter(s) within the same treatments are statistically the same (p < 0.05), WAS = Weeks after Sowing, NS=Not significant, *= significant.

The significant effect (P<0.05) of sowing method on plant height was observed at 10 WAS during the period of the trial. The highest plant height was recorded in dibbling followed by drilling at 10 WAS. The significant difference recorded could be due to variation of the planting depth and minimal competition between plants in dibbling method, which enhanced proper nutrient utilization. This is in agreement with the work of Korres and Froud-Williams (2012) who reported that planting depth and spacing favours general performance.

LEAF LENGTH

Leaf length of switch grass as influenced by sowing methods during the trial period is presented in Table 3. The results shows that sowing methods had significant (P<0.05) effect on leaf length at the 10 WAS. Dibbling method was found to be the highest with mean of 39.20 cm, while drilling method was having 35.95 cm. Broadcasting method was found to be least with 33.02 cm.

Table 3: Leaf length of switch grass as affected by sowing methods

Treatments	2WAS Cm	4WAS Cm	6WAS cm	8WAS Cm	10WAS Cm	MEAN
Broadcasting	16.61	36.53	46.93	31.32	33.70	33.02b
Dibbling	17.35	41.03	54.33	40.20	43.10	39.20a
Drilling	18.54	41.83	50.30	32.73	36.37	35.95b

Means followed by the same letter(s) within the same treatments are statistically the same (p < 0.05), WAS = Weeks after Sowing, NS=Not significant, *= significant.

Significant response in leaf length was observed from sowing method dibbling at 10 WAS. This might be attributed to the spacing in dibbling since the stands experience little or no inter-specific competition for limited resources compared to closely-spaced placed plants as in broadcasting. This was observed to depressed leaf production/plant owing to increased plant production per unit plants tend to grow more vegetatively and bear more leaves due to little competition compared with those closely placed plants.

LEAF WIDTH

The mean switch grass leaf width as affected by sowing methods during the growing period was presented in Table 4. The results revealed that the response of leaf width to sowing methods were significantly affected (P < 0.05) throughout the period of trial from tenth weeks after sowing (WAS). Dibbling method was found to be the highest with mean of 0.75 cm, while drilling method was having 0.48 cm. Broadcasting method was found to be least with 0.42 cm.

Table 4: Leaf width of switch grass as affected by sowing methods

Treatments	2WAS cm	4WAS cm	6WAS cm	8WAS cm	10WAS Cm	MEAN
Broadcasting	0.14	0.30	0.33	0.73	0.60	0.42b
Dibbling	0.44	0.70	0.80	0.98	0.82	0.75a
Drilling	0.19	0.31	0.33	0.86	0.73	0.48b

Means followed by the same letter(s) within the same treatments are statistically the same ($p < 0.05$), WAS = Weeks after Sowing, NS=Not significant, *= significant.

The leaf width of switch grass were influenced by sowing methods throughout the duration of the trial, with the highest leaf width obtained from dibbling at 10 WAS and then drilling. The effective response obtained could be as a result of less number of stands/unit area which support proper sunlight utilization, hence stem strength and leaf widening in dibbling than drilling and broadcasting. This is in conformity with the findings of Onifade and Akinola (1986).

NUMBER OF LEAVES/PLANT

Leaf number/plant of switch grass as influenced by the sowing methods during the field trial at the University Fadama Farm was presented in the Table 5. The results shows that the response number leaves/plants of switch grass to sowing methods were not significantly affected ($P<0.05$) at tenth WAS. Dibbling method was found to have the highest with mean of 6.31 cm, while drilling method was having 5.23. Broadcasting method was found to be least with 5.11.

Table 5: Number of leaves/plant of Switch grass as affected by sowing methods

Treatments	2WAS	4WAS	6WAS	8WAS	10WAS	MEAN
Broadcasting	4.60	4.27	4.80	5.53	6.33	5.11a
Dibbling	4.30	4.67	5.00	8.33	9.27	6.31a
Drilling	4.40	4.67	5.07	5.93	6.07	5.23a

Means followed by the same letter(s) within the same treatments are statistically the same ($p < 0.05$), WAS = Weeks after Sowing, NS=Not significant, *= significant.

Highest leaf number/plant was recorded in dibbling at 10 WAS, while the performance of broadcasting and drilling were statistically similar ($P<0.05$). This is in contrary to the report of Prasher *et al* (2004) who reported that sowing by broadcasting showed significant increased in all vegetative characteristics including leaf number.

HERBAGE YIELD

The response of switch grass yield to sowing methods was significantly different at ($P<0.05$). Dibbling method was found to be the highest with mean of 1.37 kg/ha, while drilling method was having 0.91 kg/ha. Broadcasting method was found to be least with 0.80 kg/ha as presented in Table 6.

Table 6: Mean herbage yield of Switch grass as affected by sowing methods

Treatments	Mean kg/ha
Broadcasting	0.80^{b}
Dibbling	1.37^{a}
Drilling	0.91^{b}
LSD (0.05)	0.27

Means followed by the same letter(s) within the same treatments are statistically the same ($P<0.05$).

The significance response recorded in herbage yield was obtained from sowing methods dibbling whereas the lowest yield was recorded in broadcasting. This contradicts the work of Evans (2002) who reported that herbage yield in lablab was higher by the influence of broadcasting method of sowing than the dibbling and drilling.

GENERAL DISCUSSION

A well-known agronomist, Talia (2010) conducted a study to determine biomass yield from alternative levels of nitrogen fertilizer for a single and double harvest per year system for four perennial grass species (bermudagrass, flaccidgrass, lovegrass, and switchgrass). Haque (2009) used the data produced in the field experiments to determine the most economical species, level of nitrogen, and harvest frequency for several sets of nitrogen fertilizer prices and hypothetical biomass prices. Haque stated that switchgrass clearly produced high yield and more dry biomass per dollar cost than the other three species. If perennial grass for biofuel feedstock is the best alternative for a field, and if the biomass price exceeds the cost of production, the optimal strategy would be to establish switchgrass, and in post-establishment years, to fertilize with 60 pounds of nitrogen per acre per year, and to harvest once per year after senescence. If an economically viable system for conversion of biomass from perennial grasses to biofuels is developed, millions of acres may be bid from current uses and seeded to switchgrass. This study would help livestock rearers (farmers) adequately in solving their major problem of fodder shortage for their animals, provided the appropriate method of sowing switch grass is employed. Based on this, future researches should focus on the use of other methods of enhancing switch grass production in semi-arid region of Nigeria.

CONCLUSION

A field trial was conducted during the 2012/2014 rainy season at Jega Teaching and Research Fadama farm of Kebbi State University of Science and Technology, based on the findings of this study, the herbage yield of the plant was significantly influenced by sowing methods at all level of treatments. The highest yield was obtained by dibbling followed by drilling and broadcasting method, respectively. Based on the results obtained, it could therefore be concluded that dibbling sowing method is the best for *Panicum virgatum* in the semi-arid Jega area of Kebbi State, Nigeria. This study would serve as the baseline for subsequent researches in the future. And the study was aimed to the use of three different sowing methods to enhance the production of switch grass and was limited to the use of switch grass for other benefits like bioenergy and soil enrichment.

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