



Journal Homepage: - www.journalijar.com
**INTERNATIONAL JOURNAL OF
 ADVANCED RESEARCH (IJAR)**

Article DOI: 10.21474/IJAR01/9801
 DOI URL: <http://dx.doi.org/10.21474/IJAR01/9801>



RESEARCH ARTICLE

EFFECT OF ROW SPACING, MINERAL AND ORGANIC FERTILIZERS ON YIELD AND GROWTH PARAMETERS OF PANICUM MAXIMUM ON FERRALITIC SOIL IN BENIN (WEST AFRICA).

Gbenou Basile¹, Adjolohoun Sébastien¹, Houndjo Daniel Bignon Maxime, Saïdou Aliou², Ahoton Léonard², Houinato Marcel¹ and Sinsin Augustin Brice³.

1. Département de Production Animale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Jéricho, Cotonou, Benin.
2. Département de Production Végétale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Jéricho, Cotonou, Benin.
3. Département de l'Aménagement et Gestion des Ressources Naturelles, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Jéricho, Cotonou, Benin.

Manuscript Info

Manuscript History

Received: 02 August 2019

Final Accepted: 04 September 2019

Published: October 2019

Key words:-

seed production, row spacing, fertilizers, ferralitic soil, Benin.

Abstract

This study proposes to evaluate the influence of the spacing row and NPK 15-15-15 fertilizer and goat manure on Panicum maximum seed production and fodder nutritive value harvested in south Benin on ferralitic soil from 2015 to 2017. The experiment was a factorial design comprising all combinations of 4 row spacings (20, 40, 60 and 80 cm) and 6 fertilizers: six levels of fertilizer: (F0) No goat manure (Control) (F1), 100 kg NPK 15-15-15, (F2) 20 t/ha goat manure, (F3) 15 t/ha goat manure, (F4) 10t/ha goat manure + 33kg NPK 15-15-15 and (F5) 5 tons + 66 Kg NPK/ha. Four replications were used in the experiment. The results showed that wider row spacing (60 cm) enhanced seed production in this experiment. Number of total tillers/tussock, fertile tillers/tussocks and spike length were significantly greater under the widest rows spacing (60 cm and 80 cm). The best seed yield got with row spacing 60 cm (392.1 kg.ha⁻¹) and 45.5% of caryopses germinate after six months of storage against 14.5% for spikelet. Seed yield and its attributes increased significantly with NPK combined to goat manures (F4).

Copy Right, IJAR, 2019,. All rights reserved.

Introduction:-

Feed shortages and the poor quality of available feed are the major constraints to increased livestock productivity in sub-Saharan Africa (Hsu, 1999; Koura, 2015). In Benin, Natural pastures are the most important livestock feed resource (Lesse, 2016). They are low yielding and their production is insufficient and grazing periods are only favorable for four to five months per year. For several decades, grazing areas have been shrinking and likely to continue to do so because of rapid expansion of cultivated land for crop production to provide food for the ever-increasing human population. As a result, there is always likely to be limited feed resources for the existing livestock population (Adjolohoun, 2008; Lesse, 2016; Mengistu et al., 2016). However, the extension and promotion of improved forage production packages is lagging behind and not progressing as expected. This is due to a number of limiting factors; among which scarcity of forage seed is the foremost (Adjolohoun et al., 2013a; Mengistu et al., 2016; Gbenou et al., 2019). Sowing a new pasture or improving an existing natural pasture requires a reliable source

Corresponding Author:-Gbenou Basile.

Address:-Département de Production Animale, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, 03 BP 2819 Jéricho, Cotonou, Benin.

of seed or vegetative material of species recommended and adapted for the area. Native grasses and legumes have evolved mainly on soils of low fertility, with climatic conditions characterized by highly variable and generally low annual rainfall. Thus, they are better adapted than most exotic species, which tend to have evolved under more benign environments (Wilson, 1994). Native herbaceous species contribute also to maintaining ecological integrity and biodiversity and provide suitable habitats for indigenous flora and fauna (Humphries et al., 1991).

Guinea grass is native to Africa with an extension zone from 20° N to 20° S and from sea level to 2500 m and above. It belongs to a very diverse genus (*Panicum*). The diversity in the genus has led to a confusing taxonomy and the delimitation of the genus is not entirely clear. Current names in use to describe *Panicum maximum* are *Urochloa maxima* (Jacq.) R. Webster (ITIS, 2012) and *Megathyrsus maximus* (Jacq.) B. K. Simon and S. W. L. Jacobs (Simon and Jacobs, 2003). In Benin, species *Panicum maximum* local is composed of 09 different ecotypes in terms of drought resistance and agronomic characteristics (Adjolohoun et al., 2012). From the ecological point of view, a good development of this plant requires at least an annual rainfall of 1200 mm of water. However, some ecotypes tolerate rainfall below 800 mm of water per year (Cook et al., 2005, Adjolohoun et al., 2008). *Panicum maximum* local can yield between 5–10 t/ha DM (Buldgen et al., 2001; Adjolohoun et al., 2013a). It has showed a very high CP (8-26% DM) and the low structural carbohydrates (NDF: 50.80%) content. Consequently, energy content (15.14 MJ/kg DM) was very high, though ash level was quite high too (16.42%DM). Macro-mineral: Ca, P, Mg and K contents are 5.87, 0.86, 1.69 and 11.04 mg/kg DM (Adjolohoun et al., 2013a; Musco et al., 2016).

The promotion of this crop in fodder production can reduce the need for livestock feed resources, increase the income of livestock breeders and reduce conflicts caused by transhumance between pastoralists and farmers among who have the land (Buldgen et al., 2001; Adjolohoun, 2008). According Gbenou et al. (2019), one of the most important factors that limit forage crop production in Benin is unavailability of seed. Seed production requires good soil fertility and mastery of production techniques. However, the soils in southern Benin are not very fertile. It is important to think of their fertilization for the production of fodder or forage seeds. Organic fertilizers including farmyard manure, poultry manure, cow manure and sheep manure may be used for the crop production as a substitute of the chemical fertilizers because the importance of the organic manures cannot be overlooked. Worldwide, there is growing interest in the use of organic manures due to depletion in the soil fertility (Gbenou et al., 2018a). Economic premiums for certified organic grains have been driving many transition decisions related to the organic farming (Delate and Camberdella, 2004). Continuous use of fertilizers creates potential polluting effect in the environment (Oad et al., 2004). Synthesis of chemical fertilizers consumes a large amount of energy and money. However, an organic farming with or without chemical fertilizers seems to be possible solution for these situations (Prabu et al., 2003)

The aims of this study were to evaluate the influence of plant spacing and organic and inorganic fertilizers on the development, production and seed quality of *Panicum maximum* local in the southern Benin on a ferralitic soil.

Material and methods:-

Description of Study Area

The trial was conducted on an experimental field during rainy seasons of 2015 to 2017. It is located at Abomey-Calavi a Guinean Soudanian agroecological zone in southern Benin (West Africa) between Latitude 06°30'N and Longitude 2°40'E with an altitude of 50 m above sea level. The area is characterized by sub-equatorial climate with two rainy seasons (March to end of July and mid-September to November) and two dry seasons (August to mid-September and December to March). The area is dominated by ferralitic soil presenting the following characteristics: pH (2/5water) 6.2; N = 0.05 %; organic carbon = 0.4 %; Ca = 60 mg/100 g; Mg = 10 mg/100 g; P (extractable) = 0.2 mg/100 g and K(exchangeable) = 20 mg/100 g (Houndjo et al. 2018). The experimental site was previously cultivated without any organic fertilization, as reflected by the low organic carbon content of the soil. The analysis conducted on 0-10 cm soil-samples showed that sand, loam and clay represent approximately 84, 8 and 8 %, respectively.

Experimental Setup: Design and Treatments

The experiment consisted of factorial combinations of six levels of fertilizer: (F0) No goat manure (Control) (F1), 100 kg NPK 15-15-15, (F2) 20 t/ha goat manure, (F3) 15 t/ha goat manure, (F4) 10t/ha goat manure + 33kg NPK 15-15-15 and (F5) 5 tons + 66 Kg NPK/ha and four levels of plant density: 20 x 20, 40 x 40, 60 x 60 and 80 cm x 80 cm. Twenty four (24) treatments combinations were laid out in a split-plot design with plant row spacing assigned to the main-plot (block), while fertilizer (goat manure or NPK fertilizer) was assigned to the sub-plot (elementary plot).

The manure was well rooted goat manure that had stabilized for about 100 days. Elementary plot size was 7 m × 7 m (49 m²) with 3 m spacing between plots and 5 m between blocks. Each plot was replicated 4 times. Goat manure was applied 2 weeks before planting and the inorganic fertilizer NPK was applied 2 weeks after planting both for the single and combined applications. Goat manure was used in this study because of its availability in the study area. Manure level (20 t/ha goat manure) retained was based on assessment of the decomposition kinetic and the nutrient mineralization process of goat' dejection (Gbenou et al. 2018b). Also, the plants density and the inorganic fertilizer level (100 kg NPK) were chosen on the basis of the recommendations for density and fertilization of forage crops recommended by agricultural supervision services in the area and research results done on seed production of this specie (*P. Maximum*) and other grasses (Barbieri, 2000; Joaquin et al., 2001; Phaikaew et al., 2001a and 2002 and Adjolohoun et al., 2013b). Rooted cutting of *P. maximum* material were used for sward establishment at the start of each rainy season during the three years of the trial (15 March 2015, 18 March 2016 and 10 March 2017) after ploughing and leveling the field. *P. maximum* ecotype used develops high resistance to dry season. It is identified as been, very interesting for both dry matter and crude protein production (Adjolohoun et al. 2012 and 2013b). The treatments were established at the same plot each year.

Data Collection

Physiologic data

Tiller density and time of floral initiation were recorded; inflorescence exsertion was deemed to occur when 50 per cent of the fertile tillers had exserted inflorescences. The plants were monitored on each plot to assess the frequency of emergence of the inflorescence. Likewise, 'days to seed maturity' was assessed as days taken from seedling emergence to first seed harvest. Seed maturity was recognized when the seed became hard, started changing color from green to brown, and when seed drop from the top racemes commenced.

Growth parameters, seed components and yield

Data were recorded throughout the experimental. Plant height and number of tillers per plant were assessed. Tillers were categorized as flowering or non-flowering and morphological characteristics of 10 flowering tillers selected randomly from each plot were measured for tiller height (base to the top of the inflorescence), tiller diameter (at the middle of the lowest internode) panicle length and panicle primary branch length. Number of panicle per tiller was recorded on 100 tillers selected randomly per plot. All seed within each plot were harvested each year over the period of seed maturity. Due to the varying row spacing, a net plot sampling area involved 10 and 5 rows of 2 m each for the 20 and 40 cm spacings respectively, then 4 rows of 1.8 m and 3 rows of 1.6 m for 60 and 80 cm spacings respectively. This corresponds to a sampling of a similar area of 4 m² for all treatments (row spacing). The Seed heads had been covered with a nylon net bag (Cover), with an outlet to collect the seed. Seed were collected every 3 days. Each year, after harvesting seed, between mi-July and late August, the plant tops were harvested to determine dry matter yield (Phaikaew et al., 2002; Kumar et al., 2005).

Seed processing and seed quality testing

Seeds of each experiments year were air-dried for 4 days after harvest in a seed shed before cleaning by using a jet of air. Seeds were afterwards stored in polyethylene bags at room temperature. Seeds were also collected from the rest of the field when shedding was on the way and stored in polyethylene bags at room temperature. Pure seed percentage was estimated using the international method using a 10 g sample for each plot, setting apart seeds and inert materials. 1,000 seed weight was estimated as the average of eight 100 pure seed replicates multiplied by 10 (ISTA, 2005). Germination tests were performed after both three and six months post-harvest storage at room temperature, because it have time period is reported as necessary for breaking dormancy and obtaining maximum germination (Matías et al., 1985). Four replicates of 100 seeds each were used in each treatment for obtaining the germination percentage.

Statistical analysis:-

Data were analyzed with the GLM (General Linear Model) procedure of SAS 8.02 software (SAS Inc., Cary, NC) using the following model : $Y_{ij} = \mu + D_i + F_j + Y_k + (D*F)_{ij} + (D*Y)_{jk} + (F*Y)_{jk} + (D*F*Y)_{ijk} + e_{ijk}$. Where μ = mean, D_i = year effect, row spacing effect, F_j = fertilizer effect, $(D*F)_{ij}$, $(D*Y)_{jk}$, $(F*Y)_{jk}$, and $(D*F*Y)_{ijk}$ Y_k their two or three ways interactions and e_{ijk} the error term. Germination percentages were transformed to arcsine $\sqrt{\%}$. When significant interaction was observed, data were re-analyzed separately by two- or one way analysis of variance. A significant was declared at $P < 0.05$ (Phaikaew et al., 2002; Kumar et al., 2005).

Results:-

Weather conditions

The average temperature and annual precipitation of the 2015 season were 26.5°C and 1048 mm. The 2016 season was slightly warm (27.0°C) and richer in precipitation (1054 mm). The average temperature and precipitation of the 2017 season were 26.8°C and 1011 respectively. The 2017 season was poorer in annual precipitation.

Growth and development attributes and dry-matter production

The effects of different treatments on various growth and development parameters are given in Table 3. Plant height increased significantly as row spacing increased with the main increase occurring between 60 and 80 cm (80cm>60cm>40cm>20cm; $p < 0.05$). Highest dry matter yield (6.4 t/ha) was recorded at 60 cm row spacing in each year, being significantly greater than the 5.7 t/ha at 40 cm, 5.5t/ha at 80 cm and 4.4 t/ha at 20 cm row spacing ($P < 0.01$). The number of tillers/m² was highest at the narrow spacing (20 cm > 40 cm > 60 > 80 cm; $P < 0.01$) in the three experimental years but tiller diameter was also best at the widest spacing ($P < 0.01$). The data about these both growth parameters were similar between years (80cm>60cm>40cm>20cm).

Application of fertilizer had a significant impact on growth parameters ($P < 0.01$). The greatest plant height and the best results of tillers number per m², tiller diameter and dry matter were recorded at the F3 and F4 levels of fertilizer (15 t/ha goat manure and 10t/ha goat manure + 33kg NPK respectively).

On high plant density plots (20 * 20cm and 40 * 40 cm) flower emergence begins with a lateness of 6 to 10 days compared with low density of plants (60 cm * 60 cm and 80 cm * 80 cm) on which floral emerge started in 70 days following crop establishment ($P < 0.05$). The gap is also very important for the time needed to obtain 50% of flowering emergence. Data on days to 50% flowering were significantly difference. Thus, the widely row spacing (80 cm) had an emergence frequency better than the others (80 cm < 60 cm < 40 cm < 20 cm). In general, flowering data showed a significant difference for start flowering time and days appropriate to obtain to 50% flowering between the fertilizer levels (F3< F4 < F1< F5 < F2 < F0, $P < 0.05$).

Seed yield and its attributes

Seed attributes were affected significantly by row spacing and fertilizer levels ($p < 0.05$) (Table 4). The number of fertile tillers per plant, inflorescence number per tiller fertile, inflorescence length and spike length were significantly higher in the wide row spacing (60 * 60 cm and 80 cm * 80 cm) as compared with narrow row spacing treatments (20 * 20 cm and 40 * 40 cm). Number of fertile tillers per plant was significantly higher in low density crop than in high density crop (80> 60 > 40> 20 cm, $P < 0.05$). The plant plots fertilized with 15 tons/ha goat manure and 10 tons goat manure + 33 kg NPK/ha produced more fertile tillers per plant, panicle/tiller fertile, panicle length and best spike length than others crops. But, fertilizer levels effects were inconsistent between treatments with on fertile tillers/tussock, Inflorescence length or spike length like growth and development attributes. However, the best results were obtained with 15 tons/ha and 10 tons + 33 kg NPK/ha fertilizers.

Seed yield and were affected significantly by both row spacing and fertilizer level (Table 5). Narrower spacing did not favor seed production of *P. maximum* in this experiment. In fact, the highest seed yield (392.1 kg/ha) was recorded from the 60 cm row spacing. This was significantly higher than yields for 80 cm (338 kg/ha), 40 cm (245.6 kg/ha) and 20cm (85.4 kg/ha) ($P < 0.001$). Overall, seed yield at the density 60 * 60 cm was 295% greater than that at the narrowest spacing seed at the widest spacing. Seed yield vary significantly with the different fertilizer ($P < 0.001$). The highest seed yield was recorded from the fertilizer F4 (10 tons + 33 kg NPK/ha) in second and third Years of the study.

Seed quality

Seed physical quality, in terms of 1,000 seed weight, showed significant differences ($P < 0.01$) between treatments. The greatest values 872.4 mg and 855.5 mg found at the 80 * 80 cm and 60 * 60 cm density respectively were not similar ($P < 0.05$) to those obtained in the 20 * 20 cm and 40 * 40 cm treatments (788.6 and 694 mg, respectively). Fertilizer using also significantly influenced the weight of 1,000 seeds ($p < 0.05$). Plots receiving F3 and F4 fertilization levels (15 tons/ha and 10 tons + 33 kg NPK/ha) produced the best weights of 1,000 seed (860.3 and 836.7 mg respectively). Overall, the weight of caryopses accounted for 47.3% of the total weight of a seed (Table 6). In addition, plant spacing affected pure seed percentage ($P < 0.01$) and the higher value (67 %) was found at the 80*80 cm distance. The second high value on seed purity level was got to the one found at the 60 * 60 cm (61.7 %). The 20 cm row spacing produced the low seed purity level (31.3%). No significant differences for levels fertilizer

influence (F1= F2 = F3 =F4= F5) on seed purity percentage between plots fertilized were found but the plots which didn't receive fertilizer (F0) produced the low seed purity level (42.7%) (Table 7).

The table 8 shows the influence of row spacing and fertilizer input levels on seed germination. Row spacing and fertilizer using didn't significantly effect on *P. maximum* seed germination ($P > 0.05$). However, seeds harvested from wider spreading plots (60 cm and 80 cm) tend to germinate better than those from smaller spacing (20 cm and 40 cm). Caryopses germination percentages after 3 and 6 months were 7.5 (%) and 45.5% respectively, compared with germination percentages of the wrapped seeds (spikelet) which varied of 3.5 (%) to 14.5 (%) between 3 and 6 months ($P < 0.01$).

Discussion:-

Grass seed production is success favored in regions which are characterized by clear, sunny, warm days in combination with little or no rainfall during flowering. These climatic conditions promote good flowering of grass species and provide an environment conducive to pollinating activity of bees, two factors essential for seed production (Rincker et al. 1988). However, rain which fell readily during flowering during June would have had consequences on the efficiency of the tillers to give inflorescences (Table 2). These rains would also have had negative effects on seed yield over the three years of the study. The choice of seeds harvest method by bags was to avoid massive losses. In contrast, the rain was less abundant during the harvest period (mid-July and late August).

Plants grown at low densities (60 cm * 60 cm and 80 cm * 80 cm) produce flowering stems faster than those grown in high density. On these plots where row spacing was widely, the frequency of emergence of inflorescences is high and 50% of inflorescences are produced in a short time. This might be due to the fact that wider inter row spacing had a better light interception as compared to the narrower row spacing. Further, more nutritional area available in wider row spacing might have caused the crop to flower earlier than the closer spacing (Farak et al.,1994). The synchronization of flowering stems emergence is useful to producer in defining the harvest period to avoid losses of seeds and working time. Knowledge of the processes related to plant development of *P. maximum* is extremely important for successful adoption of this species as forage crop. According to Hopkinson (1985), to understand the development of plants and their control which allows appropriate management for seed production, it is necessary to consider the morphology of the plant, the flowering physiology and the dynamics between the plant species and the environment at the time of flowering. The reproductive stage of most tropical and subtropical forage plant is influenced by photoperiod, temperature and humidity (Hopkinson 1985).

Data *P. maximum* species growth show that plant height is regulated by the genetic makeup of the plant and the environmental factors (Shahzad et al., 2007), and planting density determines the growing situation by affecting the competition for space and production resources. The current experiment showed significantly different plant height with varying plant density, the maximum plant height of 265 cm was obtained from 80 cm * 80 cm plant space followed by 60 cm * 60 cm plant space which was resulted with a plant height of 239.1 cm (Table 3). Minimum plant height was obtained with the lowest plant space (20 cm × 20 cm) which produced a plant height of 94 cm (Table 3). Increased plant density resulted in decreased height of the plants, this is because high plant density remains with minimum space for horizontal expansion of the plant and increase the competition for light interception between plants drives upward growth. The result of the current experiment is in agreement with Tewodros (2017), who reported that, increase in plant density, resulted in a slight increment in the height of plants. Baloch et al. (2010) and Abbas et al. (2009) also reported an increasing pattern in plant height with decreasing plant space. They reported that increase in the seeding rate resulted in a slight decline in the heights of the plants. This result, however, did not coincide with Alemayehu et al. (2015) who reported that decrease in plant density resulted in a slight decline in the heights of the plants. This could be because of variable environmental conditions and genetic makeup of the genetic characteristics of plants used in these studies. Otherwise, during the three experimental years, dry matter yield was very low at the widest (20 cm) row spacing. The low dry matter yield of fodder harvested on 20 * 20 cm density plots indicated that the low vigor of the tillers and the low plant height with leaves of reduced width and length don't favor forage production after.

Panicles form the *P. maximum* inflorescence. It is the top part of the plant, carried on the last inter-node. Panicles are composed of primary ramifications (small branches) that carry secondary branches themselves carrying the pedicels which carry the spikelet. The length of panicle plays a vital role in Paniceae plants towards the spikelet per panicle and finally the seed yield (Shahzad et al., 2007). The analysis of variance for panicle and panicle primary branch lengths shows significant difference among the treatments. Thus, a relatively higher panicle length of 116.2 cm was

recorded from 80 cm * 80 cm plant space followed by 60 cm * 60 cm which produced 108.2 cm long spike. Further decrease in planting space beyond 60 cm * 60 cm also resulted in decline in the length of panicle (Table 3). Longer panicle at 60 cm * 60 cm plant space can be referred to the ideal plant population in this treatment, which resulted in optimum crop plant competition. These results were similar with those mentioned in literature that state that inflorescence size is correlated to plant density. This finding is in-line with the findings of Abbas et al. (2009) and Tewodros et al. (2017), who reported a decreasing trend in panicle length with increasing plant population. Similarly, Ozturk et al. (2006) reported more spike production per plant with increasing pattern of plant space in Oriza (*Tritium aestivum*). For example, the larger inflorescence was found in *P. stratum* (Phaikaew et al., 2001b) at the 100*100 cm row and plant spacing, respectively, which was the largest spacing evaluated. Also, in *C. ciliaris* (Kumar et al., 2005) a larger panicle was observed when row width increased, and the largest at the 75 cm spacing. However, other authors (Matías et al., 1992; Febles et al., 1997; Sharma et al., 2002) report that plant spacing did not show significant effects on panicle length of tropical forage grasses. It is mentioned that inflorescence size is dependent on the initial size of the stem apex, on metabolite supply and on competition between the apex and other reproductive sites in plants (Humphreys et al., 1986).

The data showed statistically significant difference for seed yield. Plant space of 60 cm * 60 cm produced a higher seed yield of 392.1 kg ha⁻¹ followed by 80 cm * 80 cm plant space which produced a seed yield of 338 kg ha⁻¹. The lowest grain yield was obtained from 40 cm * 40 cm plant space followed by 20 cm * 20 cm seed rate which produced 245.6 and 85.4 kg ha⁻¹ seed yield respectively (Table 4). This finding is in agreement with the finding of Baloch et al. (2010) and Tewodros et al. (2017) who reported a decline in yield of wheat with increasing plant density. This might be explained that dense plant population creates keen competitions between plants for production resources leading to a decreasing seed yield. Similar finding also reported by Hayatullah et al. (2000) who presented a decreasing pattern in grain yield with increasing plant density.

Seed yield varied significantly with fertilizer levels. Plots that received organic fertilizer alone or in combination with the mineral fertilizer gave the best yields. The highest seed yield (331.2 kg / ha) was recorded with the 10-ton fertilizer level + 33 kg NPK / ha. Good seed yield (305.4 kg / ha) was also obtained with the fertilization level of 15 tons / ha. The lowest yield was obtained with the fertilization level of 5 tons + 66 kg NPK / ha (282.0 kg / ha), an increase of 204% compared to control. The response to N and P fertilizer resulted mainly from a combination of increased number of fertile tillers, i.e. inflorescences, greater spike length and more spikelet/panicle. Loch et al. (1999) also reported that the main effect of fertilizer N on tropical/ subtropical grass seed crops was to increase seed yield via inflorescence density. In Thailand, Gobijs et al. (2001) recorded a significant increase in inflorescence density and seed yield with the intermediate and high N levels over the low level of N in *Brachiaria decumbens*, *Digitaria milanjiana* and *Andropogon gayanus*. It is possible that organic fertilizers are more balanced than chemical fertilizers with a nutrient release rate more adapted to the need of the plant which justifies their high seed yields.

Adeniyen et al. (2005) found that integrated application of poultry manure and NPK fertilizer increased maize yield compared with poultry manure or inorganic fertilizer applications alone. This practice has shown the superiority effect of integrated nutrient supply over sole use of inorganic or organic source in terms of balanced nutrient supply (Khan et al., 2008), control of soil acidity, extended residual effect (Adeoye et al., 2011), improvement on soil physical and chemical properties and the crop yield (Ayeni et al., 2009; Ewulo et al., 2009). Combining goat manure with chemical fertilizer (NPK) treatments (F3 and F4) led to significantly higher yields and yield parameters than using chemical fertilizers alone. Therefore, it is clear that the combined application of organic manures and inorganic fertilizers is highly beneficial for sustainability in crop production (Khan et al., 2001). Based on the evaluation of soil quality indicators, Dutta et al. (2003) reported that the use of organic fertilizers together with chemical fertilizers, compared to the addition of organic fertilizers alone, had a higher positive effect on microbial biomass and hence soil health. Application of organic manure in combination with chemical fertilizer has been reported to increase absorption of N, P and K by the plant (Bokhtiar and Sakurai, 2005).

Seed physical quality indicated that plant distance influenced both 1,000 seed weight and pure seed percentage. The greater values for these parameters were obtained at the row spacing 80 * 80 cm followed by 60 * 60 cm, in coincidence with a larger pure seed yield. That shows that seed yield is a function of seeds containing caryopses (pure seed) and of seed weight. On this matter a positive effect of plant density on seed physical purity percentage is mentioned for other tropical forage grasses, *P. Atratum* (Phaikaew et al., 2001a) and *B. decumbens* cv. Basilisk (Matías et al., 1992) where plant density affected 1,000 seed weight. Regarding this, it is mentioned that the first

seeds to fall are those heavier and more mature (Humphreys et al., 1986), so pure seed yield drops. The interesting pure seed percentage and high 1,000 seed weight found in the 60 * 60 cm spacing are reflected in a larger seed yield. Although no significant effect of plant spacing and levels fertilizer on seed germination was observed, the germination rate of seeds varies according to their physical forms. Indeed 45.5% of caryopses germinate after six months of storage against 14.5% for spikelet. The germination rate varies considerably between the two test periods (3 and 6 months after storage). Other authors (Matías et al., 1992) report similar findings for seed germination in *B. decumbens* cv. Basilisk. However, some authors report that plant spacing increased seed germination rate in *C. ciliaris* (Kumar et al., 2005) and *P. maximum* cv. Común (Febles et al., 1997). This discrepancy could be due to several factors, as forage species, harvest date, storing period and conditions, germination rate methodology, post-harvest management and weather at the production and storage periods.

Moreover, this difference can be explained by the dormancy state of the seeds. Dormancy is considered as a temporary suspension of growth of any plant structure containing a meristem (Rezvani et al., 2016). These phenomena can help plants to adapt to a variety of habitats and climates and survive in different ecosystems. Seed dormancy can serve to synchronize germination so that probability of seedling survival is optimized (Baskin and Baskin, 1998). Thus, our study shown that combinational dormancy occurs in *P. maximum* seeds that have both exogenous (physical) and endogenous (physiological) dormancy.

Conclusion:-

In conclusion, the results from the study indicated that row spacing and goat manure and inorganics (NKP) fertilizers had a significant influence on the phenology, growth, yield components and yield seed of *Panicum maximum*. Seed production potential of *Panicum maximum* can to be improved with both 10 tons (goat manure)+ 33 kg NPK/ha or 15 tons/ha (goat manure) fertilizers on 60 cm x 60cm plant density plots on ferralitic soils in Benin (West Africa). Increases in seed yield can be attributed to larger pure seed percentage, greater seed weight and high panicle length. Seed physiological quality, as defined by germination, did not improve significantly in any of the evaluated treatments. The soils fertility improvement and adequate plant density choice are required to the wider use of this species in livestock systems. However, as this is one location alone, the experiment has to be repeated over locations and seasons with inclusion of more ecotypes of *P. maximum* to reach at a more reliable conclusion. Application of fertilizer will increase seed yields but economic considerations would determine whether these increases are profitable. An added benefit of wider row spacings is that seed produced is bigger and results in more vigorous seedlings.

Table 1:-The physical and chemical properties of goat manure

DM	pH	Org Carb (g/kg)	N (g/kg)	C/N	P (g/kg)	K (g/kg)	Ca (g/kg)	Mg (g/kg)	Na (g/kg)
26.9	8.3	189.0	6.0	32	4.9	7.3	7.7	1.2	0.5

Table 2:-Average monthly rainfall and mean temperature during the growing seasons of 2015–2017

Months	Temperature (°C)			Rainfall (mm)		
	2015	2016	2017	2015	2016	2017
January	26	28	27	27	0	0
February	27	28	25	0	0	0
March	27	28	29	55	11	33
April	29	27	27	155	203	169
May	26	28	28	153	133	175
Jun	26	27	26	219	217	200
July	25	26	26	118	110	122
August	25	26	26	55	101	89
September	26	27	27	112	167	105
October	28	26	26	131	109	113
November	25	25	27	23	0	3
December	28	28	28	0	3	2
Total	-	-	-	1048	1054	1011

Table 3:-Growth and development attributes of *Panicum maximum* as influenced by row spacing and fertilizer level

Treatments	Plant height at harvest (cm)	DM (t/ha)	Tillers (no/m ²)	Diameter of tiller (mm)	Dry matter yield	Days start of flowering	Days to 50% flowering*
Row spacing							
20cm * 20 cm	94d	4.4c	512.5a	5.1d	5d	67a	42d
40cm * 40 cm	187c	5.7b	382.5b	6.4c	6,9c	74b	36c
60cm * 60 cm	239.1b	6.4a	243.6c	8.2b	7.4b	84c	30b
80cm * 80 cm	265a	5.5b	195.8d	9.1a	6.3a	88d	23a
Mean	196.3	5.5	333.6	7.2	6.4	78.3	32.7
Level fertilizer							
Control	66,1d	5.2a	135.0d	3.7c	2,1b	95b	56f
100 kg NPK/ha	225,6b	5.6a	380.0b	8a	6,9a	74a	30c
20 tons/ha	187,2c	5.3a	336.0c	7.2b	7a	76a	40e
15 tons/ha	238.2a	5.8a	397.0a	8.2a	7a	76a	15a
10 tons + 33 kg NPK/ha	239.5a	5.6a	404.4a	8.4a	7.9a	74a	20b
5 tons + 66 Kg NPK/ha	221.1b	5.5a	349.2c	7.9a	7.7a	75a	35d
Mean	196.3	5.5	333.6	7.2	6.4	78.3	32.7

For the same column and the same treatment, means followed by different lower case letters are significantly different at $p < 0.05$

*Days to 50% flowering refers to the number of days taken from first emergence starting

Table 4:-Seed attributes in *Panicum maximum* as influenced by row spacing and fertilizer level

Treatments	Fertile tillers/ plant (%)	Panicle/ fertile tiller (no)	Panicle (no/ m ²)	Panicle length (cm)	Panicle primary branch length (cm)
Row spacing					
20cm * 20 cm	74b	1b	379.2a	50,4d	18,2d
40cm * 40 cm	75b	1.1b	286.2b	70,4c	21,6c
60cm * 60 cm	76a	1.3a	185.1c	108,2b	25,7b
80cm * 80 cm	77a	1.4a	150.3d	116,2a	30,1a
Mean	75	1.2	250.2	86,3	23,9
Level fertilizer					
Control	73b	1b	96.1e	60,8c	15,2d
100 kg NPK/ha	75ab	1,3a	285.6b	90,4b	25,6b
20 tons/ha	74b	1,2b	248.6d	88b	24,1c
15 tons/ha	76a	1,3a	301.7a	93,4a	26,7a
10 tons + 33 kg NPK/ha	76a	1,3a	307.3a	96,3a	27,1a
5 tons + 66 Kg NPK/ha	75a	1,1b	261.9c	89b	24,8b
Mean	75	1,2	250.2	86,3	23,9

For the same column and the same treatment, means followed by different lower case letters are significantly different at $p < 0.05$

Table 5:-Seed yield in *Panicum maximum* as influenced by row spacing and fertilizer level

Years	2015	2016	2017	Mean
Treatments	Row spacing			
20cm * 20 cm	88.5Ad	85.7Ad	82.1Ad	85.4
40cm * 40 cm	220.5Bc	276.6Ac	239.6Ac	245.6
60cm * 60 cm	377.1Aa	405.2Aa	393.9Aa	392.1
80cm * 80 cm	298.9Ab	362.9Ab	352.2Ab	338.0
Mean	246.3	282.6	267.0	265.3
	Level fertilizer			
Control	125.1Ae	83.7Be	69.3Ce	92.7
100 kg NPK/ha	307.2Aa	290.8Bd	281.4Cd	293.1
20 tons/ha	238.7Bd	322.9Ac	300.4Ac	287.3
15 tons/ha	241.4Bd	345.8Ab	328.9Ab	305.4
10 tons + 33 kg NPK/ha	275.1Bc	370.7Aa	347.9Aa	331.2
5 tons + 66 Kg NPK/ha	290.1Ab	281.7Ad	274.1Ad	282.0
Mean	246.3	282.6	267.0	265.3

For the same column, the same treatment and for the same year, means followed by different lower case letters (a, b, c, d and e) are significantly different at $p < 0.05$; For the same line, means followed by different upper case letters (A, B and C) are significantly different at $p < 0.05$

Table 6:-Effect of row spacing and fertilizer level on weight of 1,000 seeds of *P. maximum* (mg)

Treatments	Empty	Spikelet	Caryopse
	Row spacing		
20cm * 20 cm	364.6d	694d	329.4d
40cm * 40 cm	414.5c	788.6c	374.1c
60cm * 60 cm	450b	855.5b	405.5b
80cm * 80 cm	459.6a	872.4a	412.8a
Mean	422.1	802.6	380.4
	Level fertilizer		
Control	381d	724.7d	343.7d
100 kg NPK/ha	421.3c	801.7c	380c
20 tons/ha	415c	789c	374c
15 tons/ha	440b	836.7b	396.3b
10 tons + 33 kg NPK/ha	452.7a	860.3a	407.7a
5 tons + 66 Kg NPK/ha	422.7c	803.3c	380.7c
Mean	422.1	802.6	380.4

For the same column and the same treatment, means followed by different lower case letters are significantly different at $p < 0.05$.

Table 7:-Effect of row spacing and fertilizer level on *P. maximum* seed purity (%)

Years	2015	2016	2017	Mean
Treatments	Row spacing			
20cm * 20 cm	33d	32d	29d	31.3
40cm * 40 cm	51c	54c	52c	52.3
60cm * 60 cm	62b	63b	60b	61.7
80cm * 80 cm	66a	68a	67a	67.0
Mean	53	54.3	52	53.1
	Level fertilizer			
Control	44b	44b	40	42.7
100 kg NPK/ha	54a	55a	53	54
20 tons/ha	55a	56a	55	55.3
15 tons/ha	56a	57a	56	56.3
10 tons + 33 kg NPK/ha	55a	58a	56	56.3
5 tons + 66 Kg NPK/ha	54a	56a	52	54
Mean	53a	54.3	52	53.1

For the same column and the same treatment, means followed by different lower case letters are significantly different at $p < 0.05$;

Table 8:-Effect of row spacing and fertilizer level on of *P. maximum* seeds germination (%)

Storage time	Three months		Six months	
Treatments	Filled	Caryopses	Filled	Caryopses
Row spacing				
20cm * 20 cm	3a	6b	13a	44b
40cm * 40 cm	3a	7b	13a	44b
60cm * 60 cm	4a	8b	16a	47b
80cm * 80 cm	4a	9b	16a	47b
Mean	3.5	7.5	14.5	45.5
Level fertilizer				
Control	3a	7b	14a	46b
100 kg NPK/ha	4a	7b	14a	45b
20 tons/ha	3a	8b	15a	45b
15 tons/ha	4a	8b	15a	45b
10 tons + 33 kg NPK/ha	4a	8b	16a	47b
5 tons + 66 Kg NPK/ha	3a	7b	13a	45b
Mean	3.5	7.5	14.5	45.5

For the same line and for the parameter assessed, means followed by different lower case letters (a, b) are significantly different at $p < 0.05$

References:-

1. Abbas, G., Ali, M.A., Azam, M. and Hussain, I., (2009): Impact of Planting Methods on Wheat Grain Yield and Yield Contributing parameters. *J. Anim. Plant Sci.* 19(1):30-33.
2. Adeniyani, O.N. and Ojeniyi, S.O., (2005): Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. *Nigerian J. Soil Sci.* 15:34-41.
3. Adeoye, P.A., Adebayo, S.E. and Musa, J.J., (2011): Growth and yield response of cowpea (*Vigna unguiculata* L.) to poultry and cattle manures as amendments on sandy loam soil plot. *Agric. Journal.* 6(5): 218–221.
4. Adjolahoun S, Bindelle J, Adandedjan C, Toleba SS, Houinato M, kindomihou V, Nonfon, W.R.V. and Sinsin, B. (2013b): Influence de l'écartement et de la fertilisation azotée sur le rendement et la qualité des semences de *Brachiaria ruziziensis* en climat tropical sub-humide. *Fourrages*, 216: 339-345.
5. Adjolahoun, S., Dahouda, M., Adandedjan, C., Toleba, S.S., Kindomihou, V. and Sinsin, B.A. (2013a): Evaluation of biomass production and nutritive value of nine *Panicum maximum* ecotypes in Central region of Benin, *Afr. J. Agric. Res.*, 8(17): 1661-1668.
6. Adjolahoun, S. (2008) Yield, nutritive value and effects on soil fertility of forage grasses and legumes cultivated as ley pastures in the Borgou region of Benin. *Faculté universitaire des Sciences agronomiques, Gembloux (Belgique)* 109 p.
7. Adjolahoun, S., Dahouda, M., Adandedjan, C., Toleba, S.S., Houinato, M., Nonfon, W.R. and Sinsin, B. (2012): Diversité et caractérisation morphologique des écotypes de l'espèce fourragère *Panicum maximum* au Bénin. *Int. J. Biol. Chem. Sci.*, 6(5), 2043-2054. DOI: <http://dx.doi.org/10.4314/ijbcs.v6i5.14>.
8. Alemayehu, A., Wassu, M., Tamado, T. (2015): Effect of Seed Sources and Rates on Productivity of Bread Wheat (*Triticum aestivum* L.) Varieties at Kersa, Eastern Ethiopia, MSc thesis.
9. Ayeni, L.S., Adetunji, M.T., Ojeniyi, S.O., Ewulo, B.S. and Adeyemo, A.J. (2008): Comparative and Cumulative Effect of Cocoa Pod Husk Ash and Poultry Manure on Soil and Maize Nutrient Contents and Yield. *Amer.-Eur. J. of Sust. Agri.* 2(1): 92-97.
10. Baloch, M.S., Shah, I.T.H., Nadim, M.A., Khan, M.I., Khakwani, A.A. (2010): Effect of Seeding Density, and Planting Time on Growth and Yield Attributes Wheat. *J. Anim. Plant Sci.*, 20(4):239-240.
11. Barbieri, P.A. (2000): Row spacing effects at different levels of nitrogen availability in maize. *Agron. J.*, 92, 283-288.
12. Baskin, C.C. and Baskin, J.M. (1998): *Seeds-ecology, biogeography, and evolution of dormancy and germination.* San Diego: Academic Press.
13. Bokhtiar, S.M. and Sakurai, K. (2005): Effects of organic manure and chemical fertilizer on soil fertility and productivity of plant and ratoon crops of sugarcane. *Arch. Agron. Soil Sci.* 51: 325 - 334.

14. Buldgen, A., Michiels, B., Adjolahoun, S., Babatoundé, S., Adandédjan, C. (2001): Production and nutritive value of grasses cultivated in the coastal area of Benin. *Trop. Grassl.*, 35: 43-47.
15. Cook, B.G., Pengelly, B.C., Brown, S.D., Donnelly, J.L., Eagles, D.A., Franco, M.A., Hanson, J., Mullen, B.F., Partridge, I.J., Peters, M., Schultze-Kraft, R. (2005): *The Production of Tropical Forages : An alternative selection tool*. Available <<http://www.tropicalforages.info>> accessed on [15/09/2019].
16. Delate K. and Camberdella C.A., (2004): Agro-ecosystem performance during transition to certified organic grain production. *Agron. J.*, 96 (5), 1288–1298.
17. Dutta, S., Pal, R., Chakerabarty, A. and Chakrabarti, K. (2003) Influence of integrated plant nutrient phosphorus and sugarcane and sugar yields. *Field Crop Res.*, 77:43 - 49.
18. Ewulo, B.S., Babadele, O.O. and Ojeniyi, S.O. (2009): Sawdust Ash and Urea Effect on Soil and Plant Nutrient Content and Yield of Tomato: *Am.-Eurasian J. Sustain. Agric.*, 3 (1): 88-92.
19. Farag, A.M., C.J., Boese D.F., Woodward and Bergman, H.L. (1994): Physiological changes and tissue metals accumulation in rainbow trout exposed to foodborne and waterborne metals. *Envir. Toxicol. Chem.*, 13:2021–2029.
20. Febles, G., Ruiz, T.E., Padilla, C., Pérez, J., Aguilar, M., Guizado, I. (1997) : Efecto de la densidad de plantas y la nutrición mineral en la producción de semillas de hierba de guinea var. Común (*Panicum maximum* Jacq). *Rev. Cub. Cienc. Agríc.*, 31 (2):137-148.
21. Gbenou, B., Adjolahoun, S., Ahoton, L., Houndjo, D.B.M., Aliou, S., Houinato, M. and Sinsin, B.A. (2018a): Livestock manure quantification and their plant nutrient contents for crop and forage production in Benin. *Agric. Sci. Res. J.* 8(5): 117-125.
22. Gbenou, B., Adjolahoun, S., Houndjo, D., Dahouda, M., Saïdou, A., Ahoton, L., Houinato, M. et Sinsin, B., (2018b) : Systèmes d'élevage et caractérisation des déjections des porcs au Sud-Bénin. Journées scientifiques organisées à l'École Polytechnique d'Abomey-Calavi (Bénin), du 5 au 7 février 2018 au campus universitaire d'Abomey-Calavi.
23. Gbenou, B., Adjolahoun, S., Houndjo, D.B.M., Saïdou, A., Ahoton, L., Houinato, M., Dahouda, M., Sinsin, A.B. (2019): Difficulties to the crops forage integration in agricultural farms in the Sudanian area of Benin (West Africa). *Int. J. Sci. Res.*, 8 (5): 152- 159.
24. Hayatullah, K. Muhammad, A.K., Iqtidar, H., Muhamad, Z.K., Masood, K.K.. (2000): Effects of Sowing Methods and Seed Rates on Grain Yield and Yield Components of Wheat Variety Pak-8. *Pak. J. Biol. Sci.*, 3(7):1177-1179.
25. Hopkinson, J.M., Souza, F.H.D., De Diulgheroff, S., Ortiz, A., Sánchez, M. (1996): Reproductive physiology, seed production and seed quality of *Brachiaria*. In *Brachiaria: Biology, Agronomy and Improvement*, Milles JW, Maass BL, Valle CB, Kumble V. (eds). CIAT publication, n°259, Cali (Colombia); 124-140.
26. Houndjo, D.B.M., Adjolahoun, S., Gbenou, B., Saïdou, A., Ahoton, L., Houinato, M., Seibou Toleba, S., Sinsin, B.A. (2018): Socio-demographic and economic characteristics, crop-livestock production systems and issues for rearing improvement: A review. *Int. J. Biol. Chem. Sci.* 12(1): 519-541.
27. Hsu, J.H. and Lo, S.L. (1999): Chemical and spectroscopic analysis of organic matter transformations during composting of pig manure. *Environ Pollution*, 104: 189–196.
28. Humphreys, L.R. and Riveros, F. (1986): *Tropical Pasture Seed Production*, 3edn. FAO Plant Production and Protection Paper, Rome.
29. Humphries, S.E., Groves, R.H. and Mitchell, D.S. (1991): Plant invasions: The incidence of environmental weeds in Australia. *Kowari*, 2,1–134.
30. ITIS (2012). Integrated taxonomic information system [Internet]. [cited 2018 Feb 20]. Available from: <http://plants.usda.gov/java/profile?symbol=URMA3>
31. Joaquin, T.B.M., Hernández, G.A., Pérez, P.J., Herrera, H.J.G., García, S.G., Trejo, L.C. (2001): Efecto del nitrógeno y fecha de cosecha sobre el rendimiento y calidad de semilla de pasto guinea. *Téc. Pecu. Méx.*, 39, 245-254.
32. Koura, B.I. (2015): Improvement of Animal Productivity by Using Crop Residues in Integrated Crop-livestock System in Benin. PhD Thesis, 216 p. University of Abomey-Calavi, Benin.
33. Kumar, D., Dwivedi, G.K., Singh, S.N. (2005): Seed yield and quality of buffel grass (*Cenchrus ciliaris*) as influenced by row spacing and fertilizer level. *Trop Grassl*, 39 (2):107-111.
34. Lesse, D.P.A.A. (2016). Gestion et modélisation de la dynamique des parcours de transhumance dans un contexte de variabilités climatiques au nord-est du Bénin. Thèse de doctorat, Université d'Abomey-Calavi, Bénin, 299 p.
35. Matías, C. and Ruz V. (1992) : Efecto de la densidad y distancia de siembra sobre la producción de semilla de *Brachiaria decumbens* cv. Basilisk. *Pastos y Forrajes*, 15(3):219-224.

36. Mengistu, D., Bezabih, M., Hendricks, W.H., Pellikaan, W.F. (2016): Preference of goats (*Capra hircus* L.) for tanniniferous browse species available in semi-arid areas in Ethiopia. *J. Anim. Physiol. Anim. Nutr.*, 2016.
37. Musco, N., Koura, I.B., Tudisco, R., Awadjiè, G., Adjolohoun, S., Cutrignelli, M.I., Mollica, M.P., Houinato, M., Infascelli, F., Calabrò, S. (2016): Nutritional Characteristics of Forage Grown in South of Benin, *Asian Australas. J. Anim. Sci.* Vol. 29, No. 1: 51-61.
38. Oad, F.C., Buriro, U.A., Agha, S.K. (2004): Effect of organic and inorganic fertilizer application on maize fodder production. *Asian J. Plant Sci.* 3(3): 375-377.
39. Ozturk, A., Caglar, O., Bulut, S. (2006): Growth and yield response of facultative wheat to winter sowing, freezing sowing and spring sowing at different seeding rates. *J. Agron. Crop Sci.* 192:10-16.
40. Phaikaew, C., Khemsawat, C., Tudsri, S., Ishii, Y., Numaguchi, H., Tsuzuki, E. (2001b): Effects of plant spacing and sowing time on seed yield and seed quality of *Paspalum atratum* in Thailand. *Trop. Grassl.*, 35(3): 129-138.
41. Phaikaew, C., Nakamane, G., Intarit, S., Tudsri, S., Ishii, Y., Numaguchi, H., Tsuzuki, E. (2002): Effects of soil fertility and fertiliser nitrogen rate on seed yield and seed quality of *Paspalum atratum* in Thailand. *Trop. Grassl.*, 36: 138-149.
42. Phaikaew, C., Pholsen, P., Tudsri, S., Tsuzuki, E., Numaguchi, H., Ishii, Y. (2001a): Maximising seed yield and seed quality of *Paspalum atratum* through choice of harvest method. *Trop. Grassl.*, 35: 11-18.
43. Prabu, T., Narwadkar, P.R., Sanindranath, A.K. and Rafi, M. (2003): Effect of integrated nutrient management on growth and yield of okra cv. Parbhani Kranti. *Orissa J. Hort.*, 31 (1): 17-21.
44. Rezvani, M., Sadatian, S.A., Nikkhakouchaksaraei, H. (2016): Factors affecting seed dormancy and germination of greater bur-parsley (*Turgenia latifolia*). *Planta Daninha*, Doi: 10.1590/S0100-83582018360100125.
45. Rincker, C.M., Marble, V.L., Brown, D.E., Johansen, C.A. (1988): Seed production practices. In: Hanson C.H. (ed.) *Alfalfa Science and Technology*, Agronomy 29, pp. 985–1012. Madison, WI, USA: ASA, CSSA and SSSA Publishers.
46. Shahzad, M.A., Wasi-ud-Din Sahi, S.T., Khan, M., Ehsanullah, M., Ahmad, M. (2007): Effect of sowing dates and seed treatment on grain yield and quality of wheat. *Pakistan J. Agric. Sci.* 44:581-583.
47. Sharma, S.K., Yadav, M.S. and Rajora M.P. (2002): Effect of row spacing and fertilizers on growth and seed yield in buffel grass (*Cenchrus ciliaris* L.) var. CAZRI 75. *Seed Res*, 30(1):56-59.
48. Simon, B.K. and Jacobs, S.W.L. (2003): Megathyrsus, a new genetic name for Panicum subgenus Megathyrsus. *Austrobaileya*. 6:571–574.
49. Tewodros, A., Bereket, A. and Tarekegn, Y. (2017): Response of Wheat (*Triticum aestivum* L.) to Variable Seed Rates: the Case of Hawassa Area, Southern Ethiopia. *Afr. J. Agric. Res.* 12(14): 1177-1181. DOI: 10.5897/AJAR2017.12196.
50. Wilson, J.R. (1994): Cell wall characteristics in relation to forage digestion by ruminants. *J. Agric. Sci.*, 122: 173- 182.