# Assessing the Performance of Sorghum Varieties in the Guinea Savanna Zone of Ghana

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**ABSTRACT**---***Two field experiments were conducted at the Faculty of Agriculture Research Farm, University for Development Studies, Nyankpala during the two successive growing seasons of 2011 and 2012 cropping. The objective of the study was to evaluate new hybrids of sorghum (Pannar sorghum) and their level of performance in the Guinea savannah zones of Ghana. The experiment was laid in a randomised complete block design with five treatments for the 2011 seasons and ten treatments for the 2012 season. They were all replicated four times. Parameters measured include plant height, number of leaves, days to 50% flowering, stalk lodging, number of panicle per plot, biomass at harvest, panicle dry weight, 1000 grain weight and grain yield. From the obtained results, Pannar varieties performed better compared to the landrace in terms of growth and yield parameters. From these studies, famers are encouraged to cultivate more of the Pannar 606 and Macia varieties for higher grain production.***

**Keywords**--- Sorghum, Pannar, Panicle, Grain yield

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## 1. INTRODUCTION

Grain Sorghum (*Sorghum bicolor* (L) Moench) originated in Africa and it is uniquely adapted to Africa's climate (Taylor, 2011). Grain sorghum is the staple food of low income farmers in many developing countries in the semi- arid tropical areas of Africa and also use for forage and silage production (Balasubramaniyan and Palaniappan, 2007). Grain sorghum in Africa is processed into a very wide variety of attractive and nutritious traditional foods such as semi-leavened bread, couscous, dumplings and fermented and non-fermented porridges, thick and thin porridges. It is the grain of choice for brewing traditional African beers (Taylor, 2011). Sorghum grows in harsh environments where other crops do not grow well, just like other staple foods, such as cassava that are common in impoverished regions of the world. Sorghum is a drought tolerant crop but responds well if enough water is applied during its early stages to prevent any sign of drought stress (Metcalf and Elkins, 1957). It has a water requirement of 400 mm to 700 mm (Chantereau and Nicou, 1994) and grows on heavy, deep cracking vertisols and light sands. It is usually grown without application of any fertilizers or other inputs by a multitude of smallholder farmers in many countries. The yield of sorghum varies depending on the variety and the environmental conditions pertaining in a growing region. Sorghum yield harvested from farmers in Ghana vary between 500-900kg/ha in Northern region and 700kg/ha on average in Upper East and West regions annually (Al Hassan and Jatoe, 2009). According to world sorghum statistics,(2009) an average yield harvested annually by farmers in Ghana is 0.8tonnes/ha where as a developed country such as America produces over 33% of the world production from only 13% of total world area with yield productivity of 3,071 kg/ha (www.Agricultural Environmental Renewal Canada Inc, 2008). Over the past 25 years sorghum production has increased steadily in Africa, from 11.6 million tonnes in 1976 to 20.9 million tonnes in 2001. However, increased in production has been as a result of increasing the land area under cultivation and there has been no overall improvement in yield. Sorghum varieties grown by farmers in Northern Ghana are landraces which are characterised by low yielding which susceptible to diseases, pest, drought and poor nutrition. These landrace grows very tall reaching a height of 6-8 meters; couple with late maturity of 5-6 month and thereby subjecting to lodging. Several biotic factors like weather condition, soil, water supply, fertilization, variety, cutting frequency and seeding rate influence grain yields of sorghum (Stoskopf, 1981; Litzenberge, 1985). Sorghum farmers participating in a pre-season and annual planning session organised by the Research and Extension Linkage Committee (RELC) of Upper East and Upper West identified lack of improved varieties as one of

major problem to low yield (Kanton *et al*, 2007). The objective of this study is to evaluate the performance of new sorghum varieties (Pannar sorghum) in the Guinea Savana of Ghana.

## 2. MATERIALS AND METHODS

### Experimental site Description

The experiment was conducted on the research field of the University for Development Studies, Nyankpala in the Tolon-Kumbungu district, Northern Region of Ghana. Nyankpala lies on the altitude of 200 m above sea level, within latitude 09°25' N and longitude 0°58' W of the equator. It has unimodal rainfall pattern with mean annual rainfall of 1000 mm distributed from April to September. Mean minimum temperature of 23.4$^{o}$C and maximum of 34.5$^{o}$C with minimum relative humility of 46% and maximum of 76.8% (SARI, 2008). Rainfall was high and well distributed during the cropping season (Table 1). Physical properties of soil consisted of the loamy sand textural class (SARI, 2008).

### Experimental design and materials used

The experiments were conducted during the two successive cropping seasons of 2011 and 2012. The experiment was laid out in a randomized complete block design with four replications. In 2011 season, there were five treatments which consisted of two local varieties (kapaala and kadaaga) and three pannar varieties (Pannar 8609, 8816 and 606). In the 2012 season, five more pannar varieties were added. The treatment consisted of the two local varieties (kapaala and kadaaga) and eight pannar varieties (Pannar 8609, 8816, 606, 625, 895, 893, 888 and Macia). The pannar and the local varieties were obtained from Wienco Ghana limited and Savannah Agriculture Research Institute, respectively. For both experiment, a planting distance of 0.75m×0.25m between rows and within rows was used. Three seeds were planted per hole and later thinned to one plant per stand. Thinning and transplanting was done 3 weeks after sowing.

### Data collected

Data collection on growth parameters was done at two weeks interval until panicle initiation and flowering. Data was collected on the following parameters; plant emergence, plant height, days to 50% flowering, number of leaves, number of panicle per plot, panicle dry weight, number of plants lodged, grain yield and biomass weight at harvest.

### Data analysis

Data collected was subjected to statistical analysis using ANOVA (6$^{th}$ edition) and significant means were compared using Duncan's multiple range tests.

## 3. RESULTS AND DISCUSSION

### Plant height

Plant height of sorghum increased progressively from the second week after planting to the tenth week in each season. As shown in figure 1A and 1B, the differences between the varieties were significant in both seasons. In the 2011 cropping season, there was significant difference ($P<0.05$) among treatments both in 2WAP and 8WAP (figure 1A). Kapala had a significantly higher plant height which was followed by Pannar 8609. In 2012 cropping season, with the exception of pannar 895 which was not part of the 2011 varieties, Kapala and Kadaga recorded the highest plant height while the pannar varieties recorded significantly lower plant height in the eighth week (Figure 1B). Differences in plant height among varieties can be attributed to differences in genetic characteristic as reported by Ayub *et al*., (1999). This result confirmed the results of previous studies by (Abdalla 1991; Abd Rahaman, 1985; Alejandro 1982; Bakheit 1990 and Hassan, 2005) who reported that plant height significantly influence grain yield of sorghum.

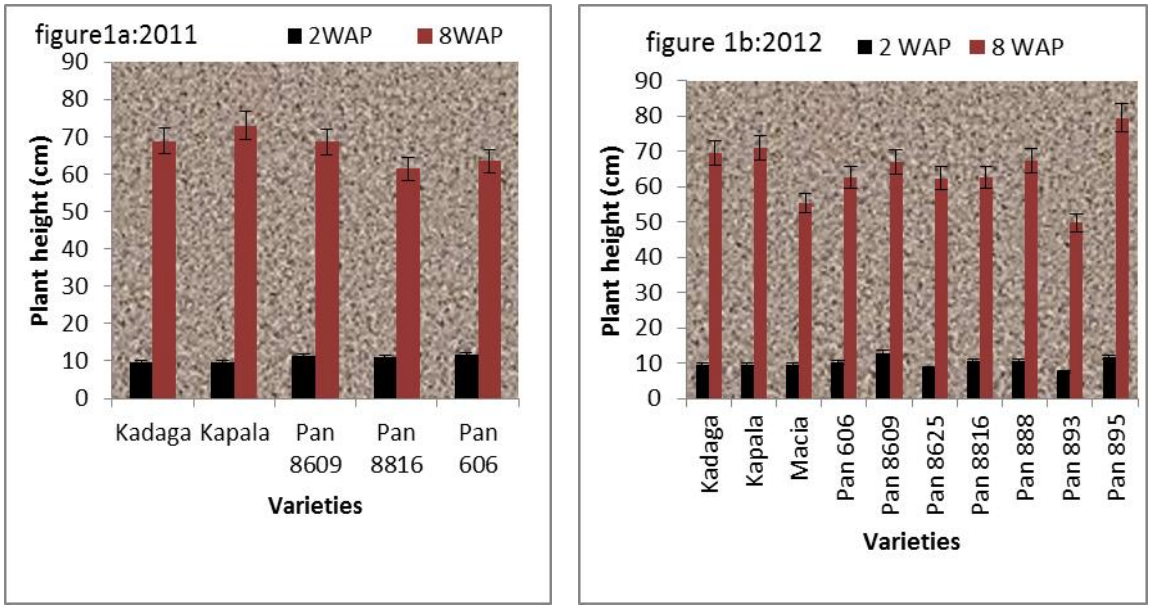


Figure 1a and 1b: Influence of sorghum variety on plant height in the 2011 and 2012 cropping season

## Plant girth

Data on plant girth was recorded only in the 2011 season. Plant girth showed significant difference ($p<0.05$) only at 10 WAP with Pannar 606 recording the highest average stem girth (figure 2). Variation in plant girth among the varieties of sorghum has also been reported by Ayub *et al.* (1999) and Yousef *et al.* (2009).

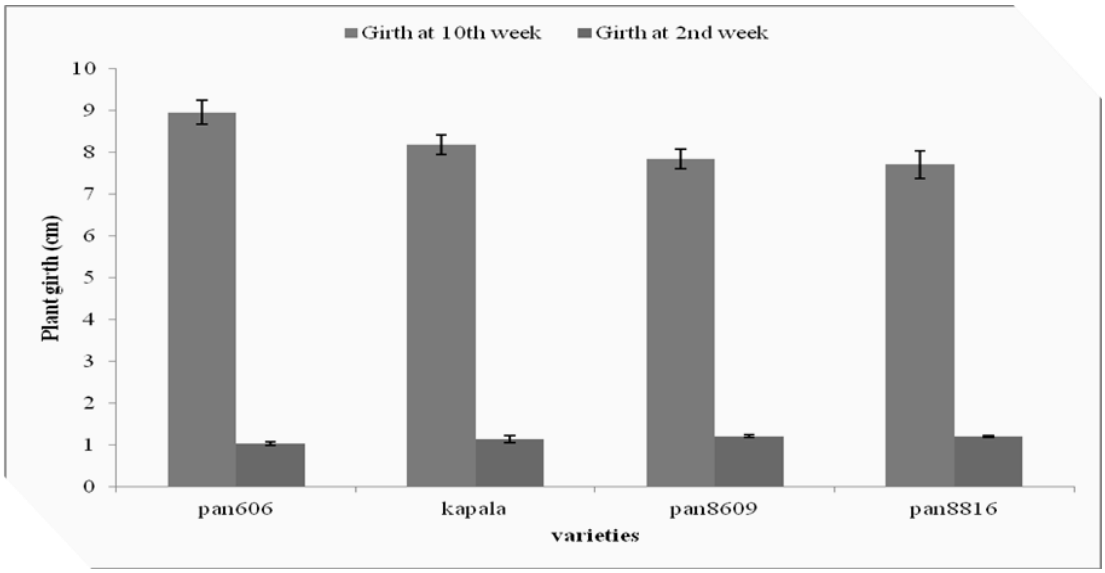


Figure 2: Influence of sorghum variety on plant girth in the 2011 cropping season

## Number of leaves

There were no significant differences ($p>0.05$) in the number of leaves at 2 weeks after planting in 2011 season, however there were significant differences ($p<0.05$) at 4th and 8th weeks (figure 3a) after planting. "Kapaala" had the highest number of leaves in both seasons. In 2012 season, there were no significant differences ($p>0.05$) on number of leaves at 2 and 4 weeks after planting, which could be due to equal growth among varieties. There were significant differences in 6 WAP. Pannar 893 records significantly lower number of leaves (Figure 3b). Number of leaves is influence by both genetic and environmental factors.

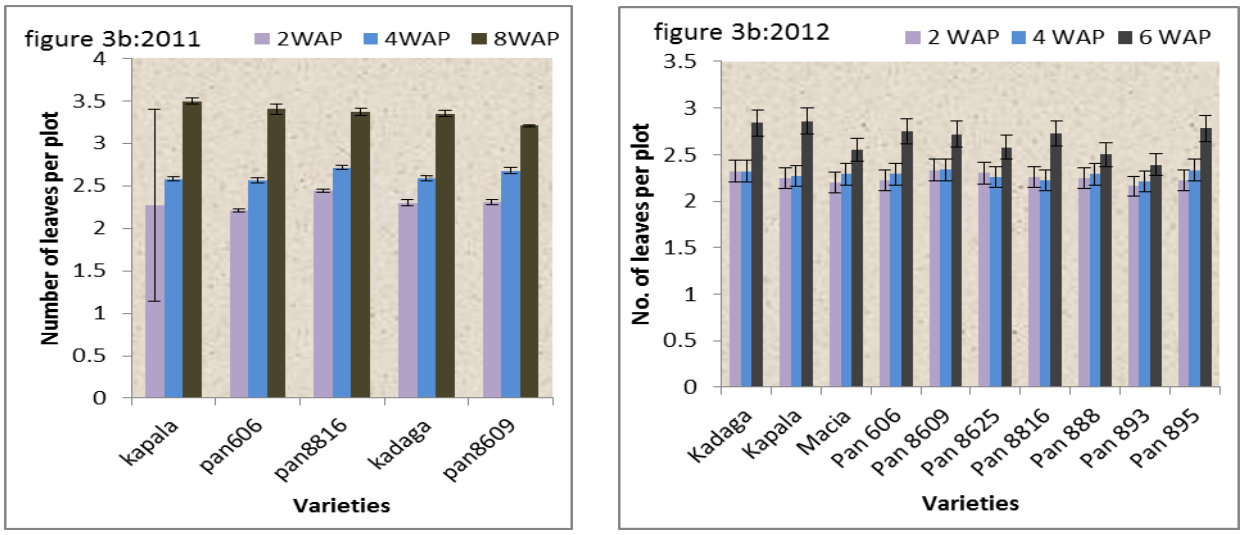


Figure 3a and 3b: Influence of sorghum variety on number of leaves in the 2011 and 2012 season

## Number of days to 50% flowering

There were significant differences among treatments on days to 50% flowering in both seasons. In 2011 season, Pannar 606 recorded the highest number of days to 50% flowering which was followed by Kapala (Figure 4a). In 2012 season, Macia recorded the highest number of days to 50% flowering which was followed by pannar 606. Among the Pannar varieties, 8609 records the lowest values. With the exception of Macia and Pannar 606, all the pannar varieties had a significantly lower number of days to 50% flowering (figure 4b). This result confirms the results of previous studies by Abdalla (1991) who found out that genotype had significant effect on number of days to 50% flowering and to days 95% physiological maturity.

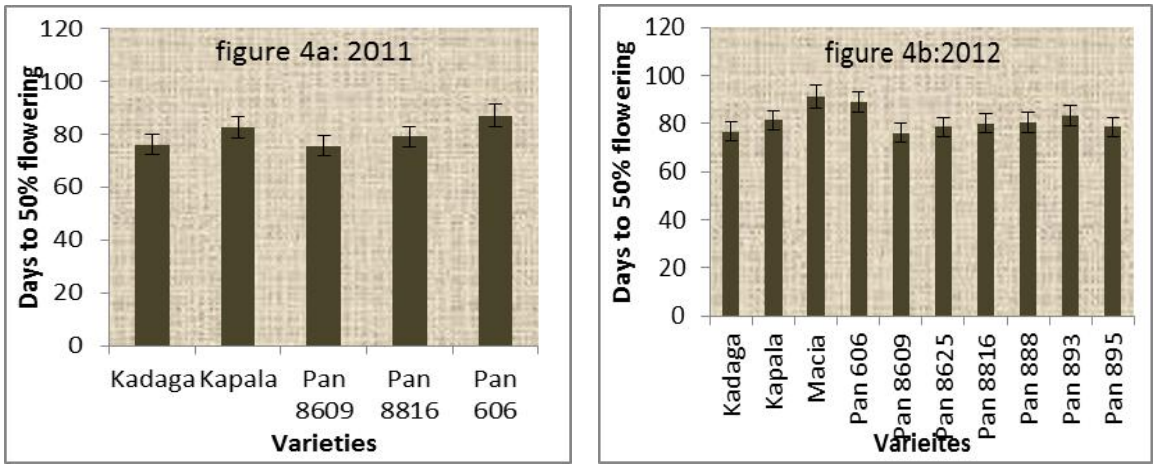


Figure 4a and 4b: Influence of sorghum varieties on days to 50% flowering in 2011 and 2012 season

## Number of panicles

Among sorghum varieties in 2011 season, the highest panicle number was recorded in Pannar 8609 and lowest panicle number recorded in "Kadaga" although "Kapaala" also recorded a lower figure (figure 5a). In the 2012 season, with the exception of Pannar 893 which was not part of the 2011 varieties, Kadaga and Kapala still recorded the lowest number of panicle (figure 5b). Comparing solely the varieties in 2011 and 2012, Pannar 8609 recorded the highest panicle number in both seasons. The difference in panicle number can be attributed to the maturity period of varieties and sowing dates which influenced grain and straw yields confirming the findings of Kanton *et al*, (2007).

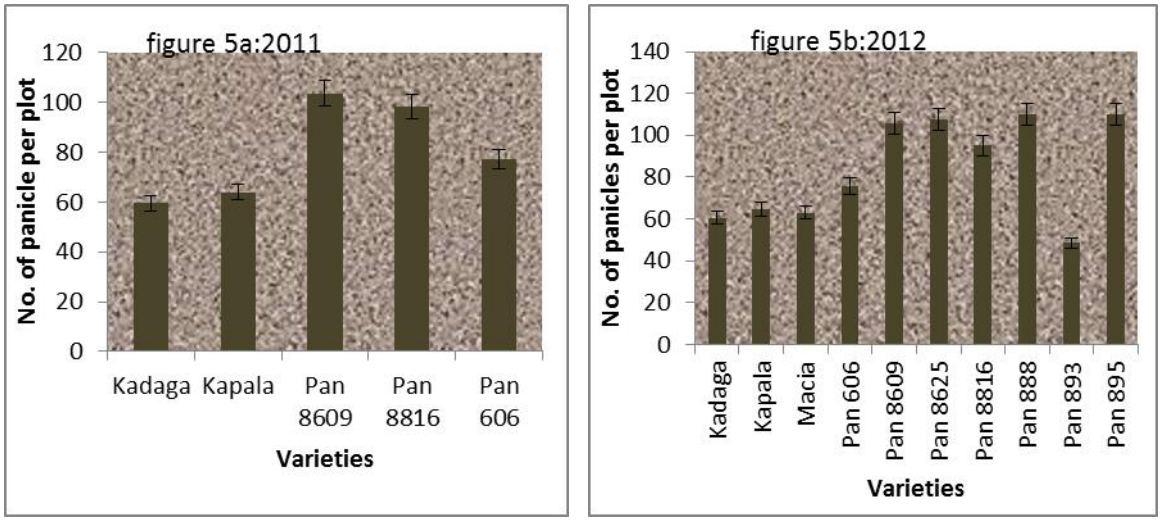


Figure 5a and 5b: Influence of sorghum variety on number of panicles in 2011 and 2012 season

## Dry panicle weight

There were significant differences ($p<0.05$) among sorghum varieties grown in both 2011 and 2012 growing seasons even though they all had uniform application rates of fertilizer and pesticide. Dry panicle weight of Pannar 606 recorded the highest panicle weight (figure 6a) per hectare in 2011 while Kadaga recorded the least panicle weight per hectare. In 2012, dry panicle weight of Macias which was not part of the 2011 varieties recorded the highest dry panicle weight followed by Pannar 606 (figure 6b). Pan 888 which was not in 2011 season recorded the lowest panicle dry weight which was followed by Kadaga and Kapala. With the exception of Pannar 888, all the Pannar varieties performed better than the local varieties (Kapala and Kadaga). The difference in panicle dry weight was a result of differences in grain weight, dry matter accumulation and water use efficiency as reported by Chohan *et al.*, (2003; 2006), Mehmud *et al*., (2003).

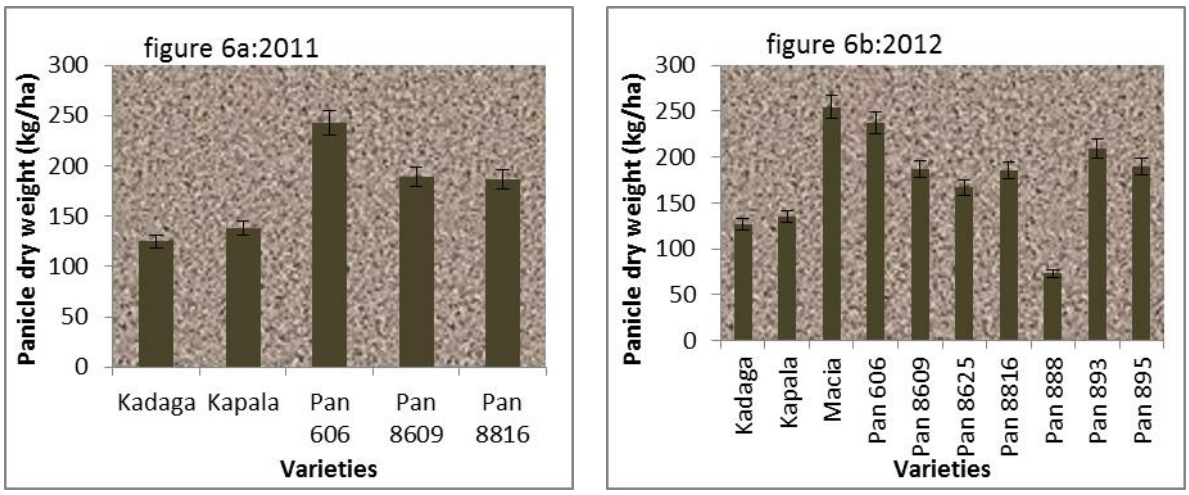


Figure 6a and 6b: Influence of sorghum variety in panicle dry weight in 2011 and 2012 season

## Number of Plant lodged

Significant differences ($p<0.001$) were recorded among treatments on the number of lodged plants. Kapala and Kadaga varieties recorded the highest number of lodged plants in both 2011 and 2012 cropping seasons. In 2011 season, kadaga recorded the highest which was followed by kapala. Pannar 606 and 8609 did not record plant lodged (figure 7a). In 2012 season, Kadaga and Kapala recorded the highest number of plants lodged which was followed by Macia. Pannar 8609, 8625 and 888 did not record plant lodge in 2012 cropping season (figure 7b). Lodging alters plant growth and development. It affects flowering, reduces photosynthetic capabilities of the plant, hence affecting carbohydrate assimilation and the yield loss comes from poor grain filling, head loss and bird damage (Elmore R. 2005). The first step to help prevent lodging is to select a variety that has short with strong straw.

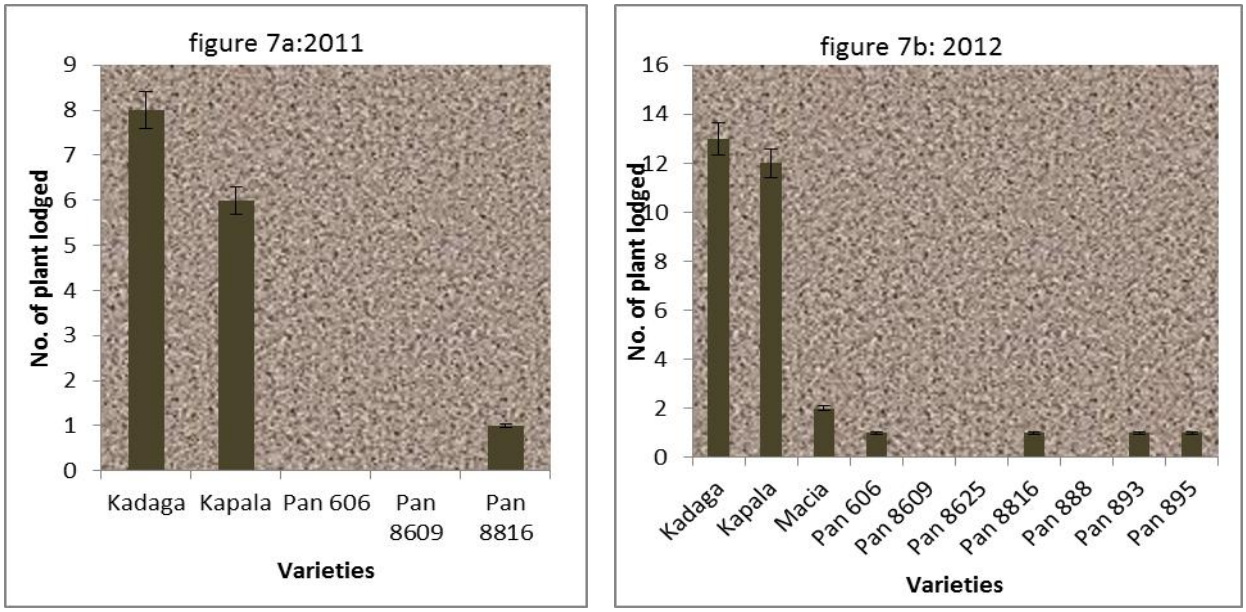


Figure 7a and 7b: Influence of sorghum variety on number of lodged plants in 2011 and 2012 season

## 1000 grain weight

The 1000 grain weight among varieties showed a high significant difference. In 2011 season, Pannar 8609 recorded the highest 1000 grain weight which was followed by Pannar 8816 (Figure 8a). In 2012 season, Macia recorded the highest value of 1000 grain weight; followed by Pannar 8609 which recorded the next highest grain weight. Pannar 888 recorded the lowest in 2012 season (figure 8b). Differences in 1000 grain weight could be attributed to differences in grain size. The differences in 1000 grain weight among sorghum varieties could be attributed to differences in genetic traits. The 1000 seed weight of cultivars was similar to finding of some researchers (Koycu and Kurt, 1997; Keshin *et al*., 2005).

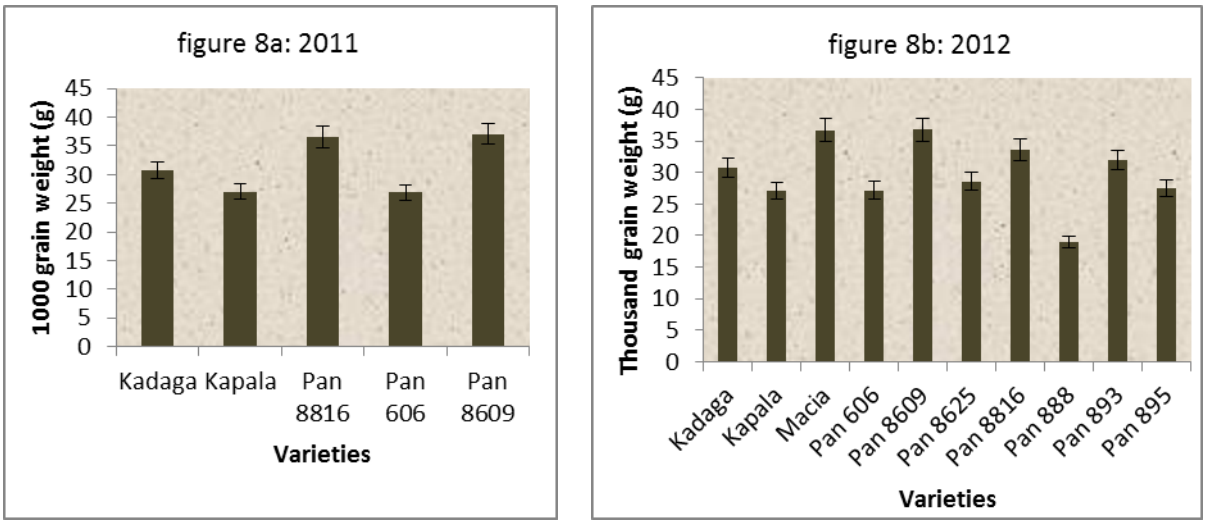


Figure 8a and 8b: Influence of sorghum variety on thousand seed weight in 2011 and 2012 cropping season

## Grain weight per hectare

Among all the varieties, there were highly significant difference ($p<0.001$) in grain weight. In 2011 season, Pannar 606 recorded the highest grain weight per hectare, followed by Pannar 8609 (figure 9a). Kadaga recorded the lowest grain weight which was followed by Kapala. In 2012 season, Macia recorded the highest grain yield per hectare which was

followed by Pannar 606 (figure 9b) and Pannar 888 recorded the lowest grain yield per hectare. The variations in grain yield per hectare among the varieties could be attributed to the fact that these varieties matured early and escaped from late drought that was observed at maturity stage of the crop. The results confirm findings by Salunke *et al.* (2003) who reported that genotypes that were drought tolerant produced the higher grain weight. The difference in grain weight can also be attributed to differences in dry matter accumulation as observed in the results from the yield components. The significant differences among sorghum cultivars in grain weight have also been reported by (Chohan *et al*, 2003; 2006; Mehmud *et al*, 2003 and Yousef *et al*, 2009).

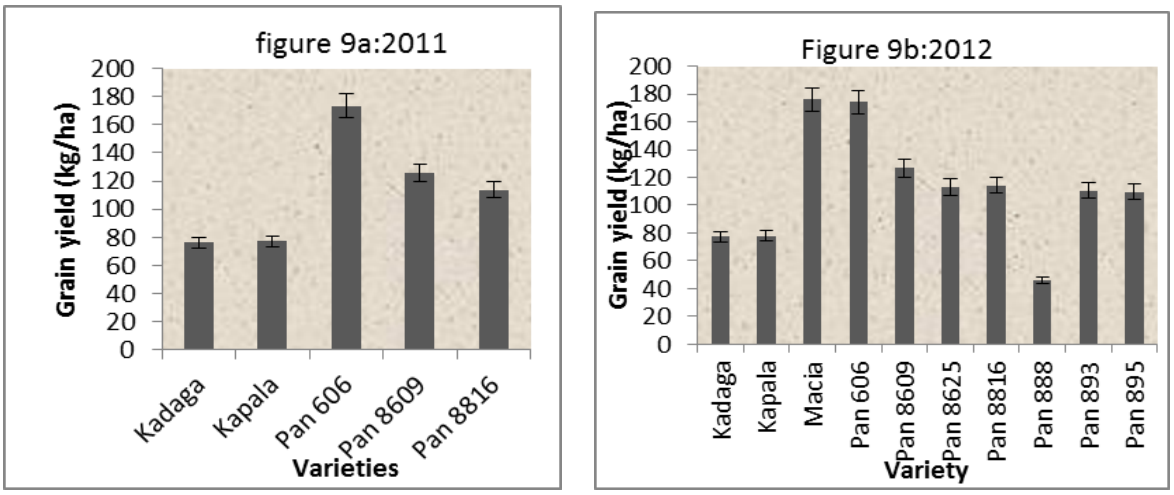


Figure 9a and 9b: Influence of sorghum variety on grain yield in the 2011 and 2012 cropping season

## 4. CONCLUSION AND RECOMMENDATION

Sorghum varieties influenced yield and yield components. All the Pannar varieties performed better than the Kadaga and Kagara with the exception of Pan 888. Among the pannar varieties, 606 and Macia recorded the highest panicle dry weight and total grain yield. Kadaga and Kapala recorded the lowest panicle dry weight and total grain yield after Pannar 888. From these studies, farmers are recommended to plant the Pannar varieties especially 606 and Macia in the Guinea savannah zone of Ghana for higher grain yield.

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**Appendix A**

Table 1: Climatic Data during the Experimental Period

| Month | Mean Maximum Temprature$^0$C | Mean Maximum Relative Humidity % | Total Rainfall (mm) | Rainy days |
|---|---|---|---|---|
| **2010** | | | | |
| June | 32.9 | 93 | 180.9 | 8 |
| July | 30.0 | 94 | 151.9 | 12 |
| August | 30.3 | 94 | 330.8 | 15 |
| September | 29.8 | 96 | 184.0 | 19 |
| October | 32.4 | 92 | 156.8 | 15 |
| **2011** | | | | |
| June | 32.2 | 91 | 250.9 | 11 |
| July | 30.6 | 93 | 145.7 | 8 |
| August | 29.7 | 94 | 255.7 | 14 |
| September | 31.0 | 93 | 210.1 | 13 |
| October | 32.7 | 89 | 102.4 | 8 |