

* Replace "big bulbs" with "large bulbs"!

EFFECTS OF CULTIVAR AND BULB SIZE AT PLANTING ON GROWTH AND BULB YIELD OF ONION (*Allium cepa* L.) IN THE NORTHERN REGION OF GHANA

Authors

ABSTRACT

Aims: To determine the effects of cultivar and bulb size at planting on growth and yield of onion ^{production in Ghana.}

Study design: Three onion cultivars were factorially combined with three bulb sizes and replicated four times in a randomized complete block design. *①

Place and Duration of Study: The study was conducted at the Experimental fields of the University for Development Studies, Nyankpala in the Northern Region of Ghana from 12 July to 26 October, 2013. X

Methodology: The three onion cultivars used for the study were Bawku red, White onion and Nigel brown. The bulb sizes used were large bulb (45-60 mm in diameter), medium bulb (30-45 mm in diameter) and small bulb (15-30 mm in diameter). Bulbs from these treatment combinations were planted on the field and growth and yield parameters were measured. X

Results: Results indicated that bulb size at planting influenced vegetative growth and yield parameters of onion. The big bulb of all cultivars recorded the highest performance in relation to the parameters considered but the small bulb generally recorded the lowest growth and bulb yield of onion. No significant cultivar difference was observed in terms of growth, but Bawku red had higher bulb yield than the other cultivars. *②

Conclusion: Onion growers especially those from the study area should use big (45-60 mm in diameter) bulbs of Bawku red cultivar during the time of planting for high quality and yield of the crop. *③

Key words: Onion, cultivar, bulb size at planting, growth, bulb yield

leaf length, number of leaves, bulb mass, "sprouts"

1. INTRODUCTION

Onion (*Allium cepa* L.) is believed to have originated from Central Asia. Both mature and immature bulbs of this crop are used as vegetables and condiments in Ghana. Onion contains vitamin B and traces of vitamin C, iron and calcium. According to [1] onion is one of the oldest crops known to man. [2] stated that onion has many uses, and recent research findings suggest that onion in the diet of man may play a part in preventing heart diseases. The crop has therefore been used to treat a wide range of ailments but the most prominent ones have been cardiovascular diseases. Onion intake has been associated with significant reduction in blood pressure, cholesterol and platelet aggregation [3]. [4] reported that there has been a reduction in the number of cases of sicknesses in relevant clinical feeding trials with onion. This author reported that significant applications have been noted for the antimicrobial property of onion because the crop has been used to treat many diseases caused by bacteria, fungi and viruses. In fact, intake of onion has not only resulted in reduction in carcinogenesis and blood sugar levels but increases in insulin and general antioxidant activity in man. Reference?

In recent times, there has been tremendous interest in the influence of cultivar and bulb size at planting on growth and yield of onion in Northern Ghana. In onion production, it has been noted that the size of the bulb is dependent upon the number and sizes of the green leaves at the time of maturity. For each leaf there is a ring of onion and the larger the size of the leaf, the larger will be the ring. It has also been established that sound whole bulb sizes with diameters ranging from 45 to 55 mm should be used as planting material. [5] reported that medium sized bulbs were required for high bulb yield. Similar results were also reported by [6] and [7]. Planting using the bulb is probably the simplest method. In fact, in using the bulb, development is faster and plants get strong and resist attack by thrips. The mother bulb size has been known to have pronounced effect on growth and yield of onion [8]. However, in plant production, different cultivars of a particular crop species may have different growth, agronomic or yield characteristics. The present study therefore aimed at evaluating the influence of cultivar and bulb size at planting on growth and yield of onion. In particular the study sought to determine the particular bulb size that will give optimum response in terms of growth and bulb yield among the three cultivars used for the study. Reference? (x mm)?

What is the medium size [5] refer to. What similar results are you referring to [6] + [7]. Were they all referring to the same small, medium and large sizes

2. MATERIALS AND METHODS

2.1 Site description

The study was conducted at the University for Development Studies, Nyankpala, which is 16 km West of Tamale in the Tolon-Kumbungu District of the Northern Region of Ghana. The site is located on latitude $09^{\circ} 25'$ and longitude $0^{\circ} 58'$ of the equator and at an altitude of 183 m above sea level. The site has a unimodal annual rainfall of 1034.4 mm and mean monthly minimum temperature of 21.5°C and maximum of 34.1°C . The mean monthly minimum relative humidity of the area is 53% while the maximum relative humidity value is 80%. The area is located within the Guinea Savannah agroecological zone of Ghana and the vegetation is made of mostly tall perennial grasses such as *Adropogon gayanus* intercepted with trees and shrubs. Soils of the area are described as alfisols under the USDA system of classification [9]. They are mostly brown, moderately drained sandy-loam and are free from concretions. They are very shallow with hardpan under the top few centimeters. The soils were developed from voltarian sandstone and classified as Nyankpala series or Plinthic Acrisol [9]. The pH of the soils ranged from 4.71 to 5.32, the effective CEC was 2.73 – 3.92 Cmol/kg and the available N content was 0.18 g/kg. The P and K content were 2.86 mg/kg and 8.5–9.2 mg/kg, respectively while the organic matter composition was 0.81%.

* Ca / mg ?
* Clay % ?

This can be presented in a table format

2.2 Land preparation, experimental design and planting

The study was a 3×3 factorial experiment laid out in randomized complete block design (RCBD) with 4 replications. The following cultivars: Bawku red, White onion and Nigel brown, which are the dominant cultivars in the study area, were used. Three bulb sizes viz. large bulb (45-60 mm in diameter), medium bulb (30-45 mm in diameter) and small bulb (15-30 mm in diameter) were considered for each cultivar. The field was ploughed and debris removed; it was demarcated using lining and pegging and the beds were raised using a hoe before bulbs were planted.

2.3 Data collection

Leaf length was measured as distance from the point of attachment of the longest leaf to the stem (basal plate). Leaf and tiller numbers were obtained by counting their total numbers per plant. At harvest the weight of the bulbs were measured as bulb fresh weight. The data collected were subjected to analysis of variance (ANOVA) using Genstat statistical software and means separated with Fisher LSD test at 5 %.

3. RESULTS

3.1 Leaf length

Figure 1a shows the influence of bulb size of Bawku red cultivar on leaf length. At 2 weeks after planting, the small bulb recorded the highest mean leaf length of 16.68 cm while the medium and big bulbs recorded values of 13.89 cm and 13.13 cm, respectively. From 4 - 6 weeks after planting, the three bulb sizes recorded significantly similar values of leaf length. From Figure 1b, it can be observed that, bulb size influenced leaf length of White onion significantly. At two weeks after planting, there was a highly significant difference between the big bulb and the other two bulb sizes. The big bulb recorded the highest leaf length followed by the small bulb with the medium bulb recording the lowest value. At 4 weeks after planting, leaf length value for the big bulb was 27.26 cm, while the small and medium bulbs recorded 18.88 cm and 16.25 cm, respectively. At 6 weeks after planting, however, the big, medium and the small bulbs recorded 31.79 cm, 28.50 cm and 23.26 cm, respectively of leaf lengths. Figure 1c shows the leaf length distribution of the Nigel cultivar. It was observed that, there was rapid growth of leaves from 2-4 weeks after planting. At 6 weeks after planting, it was observed that, the growth of leaf of the medium bulb slowed down as the small and big bulbs increased. The trend in the growth pattern changed. The big bulb and the small bulbs recorded significantly higher and similar

CV. White onion
Cultivar White onion $\rightarrow$ but if you only refer to 'White onion'!

values of length as compared to that of the medium bulb. The mean leaf length of the medium bulbs decreased drastically from week 4 to week 6. Was this a significant decrease? $\Rightarrow$ of plants from

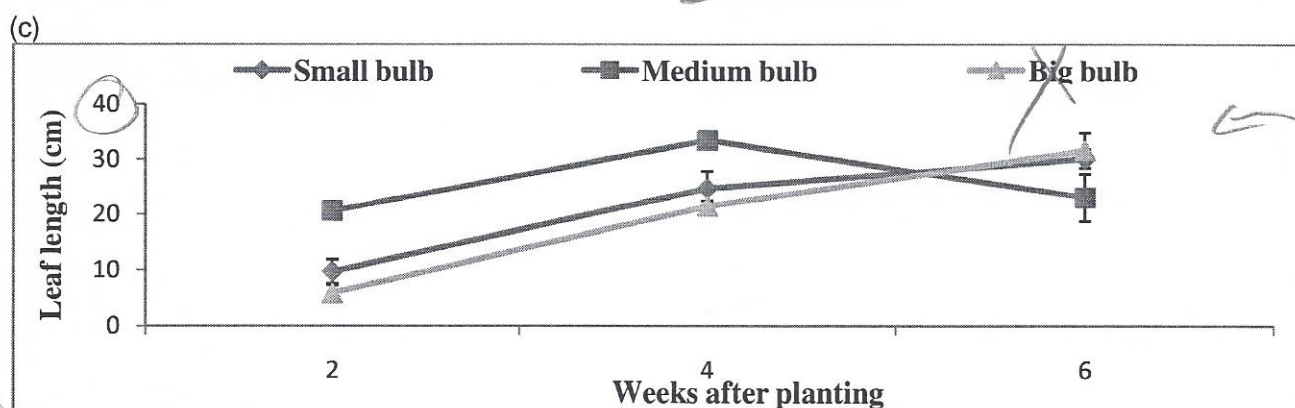
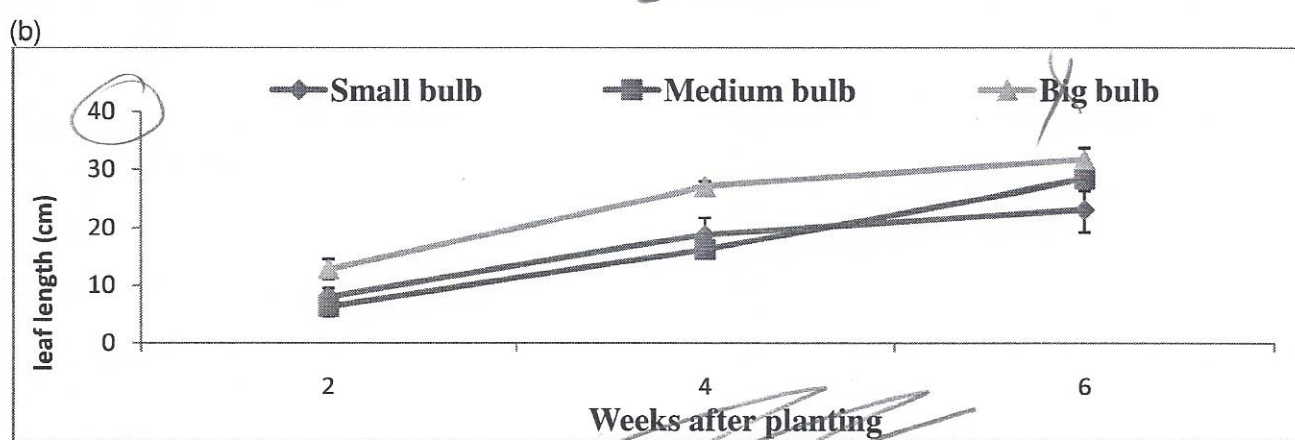
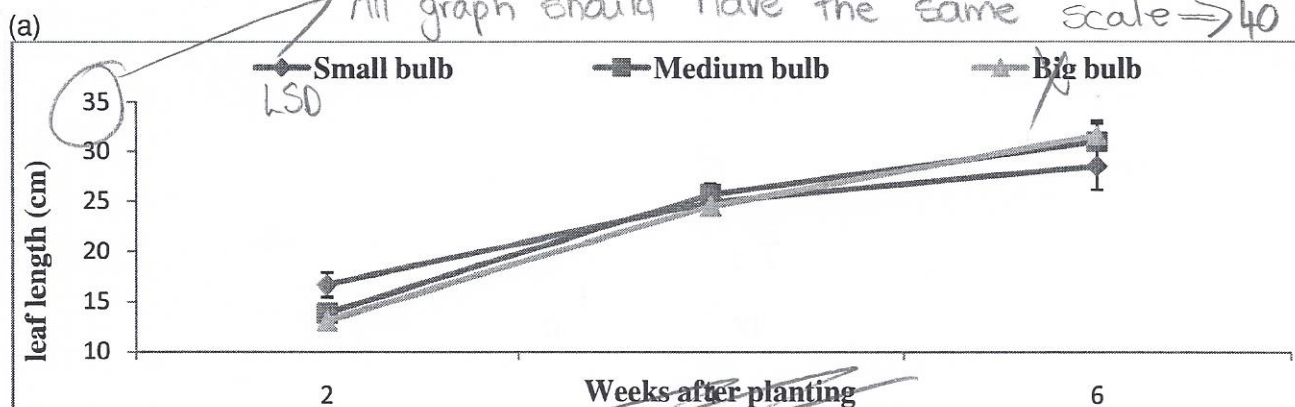


Fig. 1. Effect of bulb size on leaf length of (a) 'Bawku red', (b) 'White onion' and (c) 'Nigel brown' onion. Bars represent mean $\pm$ S.E. of 4 replicates.

LSD 2 weeks after planting = x
 LSD 4 " " " = y
 LSD 6 " " " = z

3.2 Number of leaves

Fig 2a shows the distribution of leaf number of Bawku red onion. Number of leaves was significantly different for the various bulb sizes. Generally number of leaves increased from 2 to 6 weeks after planting. At 2 weeks after planting, plants from the medium bulb recorded the highest leaf number while those from the big and small bulbs recorded significantly the same values. At 4 weeks after planting, plants produced from the medium and big bulbs had significantly similar leaf numbers while those from the small bulbs recorded the least. At 6 weeks after planting, plants from the big bulb recorded the highest mean leaf number followed by those of the medium bulb and the small bulb in that order. In the case of White onion (Fig 2b), plants from the big bulb produced the highest number

of leaves from 2 - 6 weeks after planting. Plants from the small and medium bulbs did not significantly vary in leaf number from 2 - 4 weeks after planting but at 6 weeks after planting, plants from the small bulb recorded the least number of leaves. Fig 2c shows the leaf number distribution among the various bulb sizes of Nigel brown cultivar. Plants from the medium bulb recorded the highest number of leaves at 2 weeks after planting whilst those of the big bulb recorded similar number of leaves as those of the small bulbs. At 6 weeks after planting, plants from the big bulb recorded significantly the highest number of leaves while those of the small and medium had similar values.

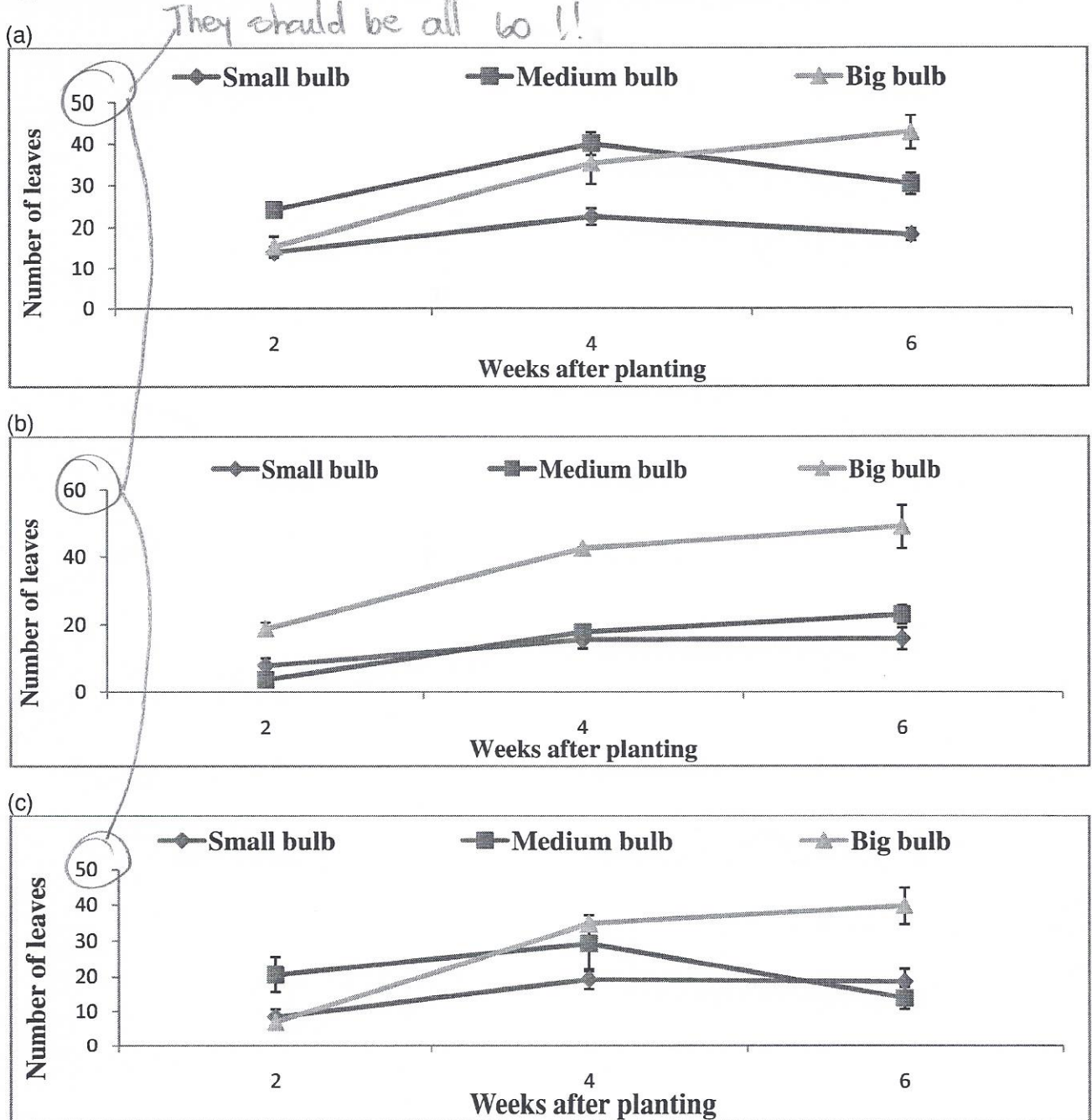


Fig 2: Effect of bulb size on leaf production of (a) Bawku red, (b) White onion and (c) Nigel brown onion. Bars represent mean $\pm$ S.E of 4 replicates.

3.3 Number of tillers and harvested bulbs

Bulb size of onion significantly influenced number of tillers ($p < 0.001$) while cultivar had no significant influence on number of tillers (Table 1). The interaction between cultivar and bulb size was ~~not~~ significant. Among the bulb sizes, tiller number decreased in the order big bulb > medium bulb > small

(Table 1)

was this always significant?
 This decrease from one size to the other was not always significant for all cultivars

bulb, though no significant difference was observed between plants from the small and medium bulbs. In the case of cultivar, the decreasing trend was Bawku red > White onion > Nigel brown. In general, plants produced from big bulbs of Bawku red and White onion gave the highest tiller production while small bulbs of Nigel brown recorded the least number of tillers. Bulb sizes at planting also affected number of bulbs at harvest significantly ($p < 0.001$), though no significant difference was observed between plants produced from the small and medium bulbs. Cultivar, however, had no significant influence on number of bulbs produced (Table 2). Also, the interaction between cultivar and bulb size was not significant. In general, plants from the big bulb produced the highest while those from the small bulbs recorded the least number of bulbs at harvest. Plants from the big bulbs of White onion gave the highest number of bulbs while those of the small bulbs of the same cultivar gave the least.

Table 1: Influence of cultivar and bulb size at planting on tiller number of onion

Cultivar	Bulb size			Mean
	Small bulb	Medium bulb	Big bulb	
Bawku red	12.75	21.25	32.50	22.17
White onion	13.25	15.50	32.75	20.50
Nigel brown	12.25	18.75	26.50	19.17
Mean	12.75	18.50	30.58	

CV (%) = 20.8; LSD (0.05); Cultivar = 3.61; Bulb size = 3.61; Cultivar x Bulb size = 6.25.

LSD (0.05) Cultivar = not significant
LSD (0.05) Bulb size = 3.61

Table 2: Influence of cultivar and bulb size at planting on number of bulb at harvest

Cultivar	Bulb size			Mean
	Small bulb	Medium bulb	Big bulb	
Bawku red	11.50	14.50	17.75	14.58
White onion	8.00	9.75	21.75	13.17
Nigel brown	10.00	16.00	18.75	14.92
Mean	9.83	13.42	19.42	

CV % = 28.0; LSD (0.05): Cultivar = 4.55; Bulb size = 4.55; Cultivar x Bulb size = 7.89

ns

ns

ns

3.4 Bulb fresh weight at harvest

At harvest, Bawku red gave the highest bulb fresh weight from all bulb sizes. Bulb yield of White onion was high, and was significantly similar to that of Bawku red when big bulb was used for planting; however, White onion recorded the least bulb yield in terms of bulb fresh weight from either the small or medium bulb (Fig 3).

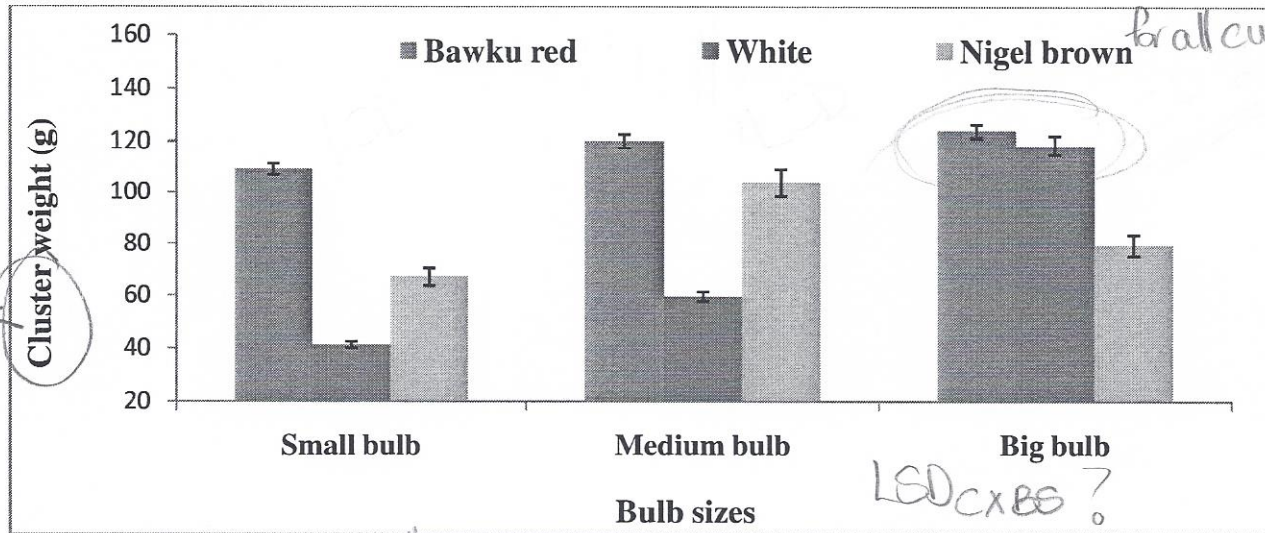


Fig. 3 Influence of bulb size on fresh weight at harvest of the three cultivars of onion. Bars represent means $\pm$ SE of 4 replicates.

4.0 DISCUSSION

Results of the current study indicated that in general, the larger the mother bulb size, the greater the bulb yield. [10] also reported that when bulbs of suitable sizes are planted, increases in yield of onion were observed. In this study, significant differences in bulb sizes used as planting materials were recorded for leaf number and length. The highest in these parameters were produced by the big bulbs but the parameters decreased with decreasing bulb size for all the cultivars. In my other but related study on drought stress in onion using bulbs of different sizes in Northern Ghana (paper yet to be published), and also from my study on ornamental geophytes [11] similar observations were made. In this study, the increases in number of leaves were directly related to the number of tillers. That is the higher the number of tillers the higher the number of leaves produced. This finding agrees with the observation by [12] as well as [13]. In general, large bulbs contain high amounts of reserved carbohydrates [11] and this was probably responsible for the high sprouting initials especially in the case of the large bulbs, resulting in their production of higher number of leaves and tillers as compared to the small bulbs. The size of the onion bulb is dependent upon the number and size of the green leaves at maturity. For each leaf there is a ring of onion and the bigger the leaf, the bigger the ring. Different bulb sizes exhibit significant variation in respect of leaf number per plant at different days after planting. The number of leaves per plant gradually increased for the big bulb sizes in each cultivar from two to six weeks after planting. The same trend was observed within the small and medium bulbs, but at sixth weeks after planting, the number of leaves for the small and medium bulbs reduced due to drying of the lower leaves. The increases in number of tillers from the small to the big bulb may be attributed to more shoot premodia formed of the big bulb as compared to those of the small bulb sizes. In fact in bulb production, each tiller is capable of producing one or more bulbs. Therefore, the higher the number of tillers produced, the higher were the number of bulbs counted at harvest. Tiller and bulb production did not vary significantly among the cultivars. Lack of variation in numbers of tillers and bulbs of the cultivars, among other factors, may be due to lack of significant genetic differences in these cultivars.

The highest bulb fresh weight (Fig 3) was obtained from the big bulb. According to [14], big mother bulbs do not only have a higher food supply but they also have relatively high water content as compared to small and medium bulbs. It is probably because of this attribute of big bulbs that enhancement in the development of vigorous plant growth and production of higher bulb yield was

observed. This explains why plants produced from big bulbs recorded higher bulb yield (fresh weight) than those of small and medium bulbs in the present study. Similar trends in seed yield have been reported by other workers ([15]; [16]; [17]; [18] and [19]). It was also observed that Bawku red cultivar had an advantage in almost all the growth and yield parameters considered in this study, probably because of its superiority in terms of adaptation to the environmental conditions in Northern Ghana as compared to the other cultivars.

you cannot compare seed onions with bulb producing onions!!

5.0 CONCLUSIONS

The study has revealed that the size of the bulb used for planting in onion is very important for the growth and bulb yield of the crop. Large bulbs produced higher number of leaves, tillers and bulb yield of onion as compared to those of small bulbs. The three cultivars used did not show any significant difference in vegetative growth but Bawku red had higher bulb yield than the other cultivars. The study concludes that when farmers use big bulb size (45-60 mm in diameter) of Bawku red as planting materials during the time of planting they will obtain higher yield and productivity of onion in Northern Ghana.

ACKNOWLEDGEMENTS

We express my sincere gratitude to the Faculty of Agriculture of the University for Development Studies for providing funds for land preparation prior to planting and also making the arable fields at the 'farming for the future' available for this study. We also thank all technicians in the Department of Agronomy of the University for helping in collecting data collection, and also assisting in weeding the experimental plots and carrying out other cultural practices during the time of experimentation.

AUTHORS CONTRIBUTION

Dr. I.K. Addai designed the study, supervised data collection and wrote the first draft of the manuscript. Mr. R. K. Tsitsia performed the statistical analysis while Mrs H. Takyi read through the manuscript and edited it after it has been drafted by Dr. I. K. Addai.

REFERENCES

1. Sinnadurai S. Notes on the bulbing and flowering habits of the "Bawku" onion. Trop Agric (Trinidad). 1970; 47: 77-79.
2. Currah L, Proctor FJ. Onion in Tropical Regions. Bulletin 35. National Resource Institute. Chathan UK. 1990; 91-93, 151 p.
3. Block E. The organosulfur chemistry of the genus *Allium*: Implication for organic sulfur chemistry "Angewandte chemie International Edition, English. 1992; 31: 1135-178.
4. Lawson LD. "Garlic: A Review of its Medicinal Effect and Indicated Active Compound." In phytomedicines of Europe, L. D. Lawson and R Bauer (ed) 17609. American Society Symposium Series no. 691. Washington, D. C America Chemical Society. 1998.
5. El- Hilo AE, Nourai AH. Management practices recommendation for commercial onion (*Allium cepa* L.) seed production in the Sudan. Proceedings of the crop husbandry committee, 22 May 1988, ARC. 1988. Wad Medani, Susan.
6. Singh DSH, Rewal HS, Brar SS, Singh L. Effect of bulb size, spacing, time of planting, insecticides and fungicides on the production of onion seed in the South - Western Region of Punjab, India. Onion Newsletter for the tropics. 1990. 2:40.

space

XXX
XX

Is this a book?

X

X

7. Perez AP, Decon LM, Mayer ZF. Influence of onion bulb size and its locality of origin on seed yield. Onion newsletter for the tropics. 1996. 7: 25 – 32.
8. Karim RMF, Ahmed F, Hoque MM. Effect of bulb size and spacing on bulb yield of onion. Bangladesh J. Agric. review. 1999. 24(4): 609- 613.
9. Nyankpala Agricultural Experimental Station (NAES) Annual Report. CSIR/GTZ joint project Report. 1984. Nyankpala. 1-2.
10. Khokhar KM, Hussain SI, Mahmood T, Hidayatullah MH, Bhatti MH. Effects of sett size on bulb yield, maturity and bolting in local and exotic cultivars of onion during autumn season. Sarhad J. Agric. 2001.17: 355 – 358.
11. Addai IK, Scott P. Influence of bulb sizes at planting on growth and development of the common hyacinth and the lily. Agric and Biology Journal of North America. 20112 (2): 298 – 314.
12. Singh SR, Sachan BP. Interaction of bulb size and spacing on seed yield and yield attributing traits on onion (*Allium cepa* L.). cv Kalyanpur Round Red. Sci. Hort.1999. 6: 125 – 128.
13. Hussain SW, Ishtiaq M. Hussain SA. Effect of different bulb sizes and planting dates on green leaf production of onion (*Allium cepa* L.). Online J. Biol. Sci. 2001.1: 345 – 347.
14. Levy D, Ben-Herut Z, Albasel N, Kaisi F, Manasra I. Growing onion seeds in an arid region: drought tolerance and the effects of bulb weight, spacing and fertilization. Sci. Hort.1981. 14: 1 – 7.
15. Ambulker MR, Kale PB, Gonge VS, Mahorkar V K. Effect of bulb size and spacing on the yield and quality of onion seed (*Allium cepa* L) PKV Res. J. 1995. 19 (2); 107- 109.
16. Abedin MJ, Rahim MA, Islam KS, Haider MA. Effects of planting date and bulb size on the yield and quality of onion seed. Bangladesh J. Seed Sci. Tech.1999. 3: 25 – 28.
17. Muktadir MS, Farouque AM, Rahim MA, Hussain MM. Yield and quality of onion as influenced by the planting time and bulb size. Bangladesh J. Seed Sci. Technology. 2001. 5: 47 – 52.
18. Verma TS, Chand R, Thakur PC, Lalkhan pal KD, Singh A. Effect of bulb size and plant spacing on yield of onion. Indian J. Hill, Farming. 1994. 7:102 – 104.
19. Baloch MA, Hussain SA, Ali N. study on the effects of planting space and bulb size on seed production in onion crop. Sharhad J. Agric.1998. 14 (6): 563 – 568.