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Full Length Research Article

Effects of Caffeine on the Seed Germination of Bambara Groundnut (*Vigna subterranean* (L.) Verdc)

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ABSTRACT
This study was conducted to determine the effects of different caffeine concentrations on seed germination of Bambara groundnut. The seeds were pre-soaked in distilled water for 12 hours and then exposed to the different concentrations of the caffeine doses prepared on weight basis, i.e. 0.005 %, 0.25 %, 0.5 %, and 0.75 % 1.0 %, 1.25 %, 1.5%, 1.75% and 2.0% w/w caffeine in solution, prepared in a phosphate buffer of pH-7 2. Three replications of the treatments were made and sown with each seed of the treated concentrations in a pot using a Complete Randomized Block Design (CRBD). Seed germination was scored for seven days and the germinated seedlings were further observed for 9 weeks. The radicle length, shoot height, and stem girth were measured weekly after germination. From the results, it was evident that increased concentration of caffeine reduced the germination percentage of the seeds. The caffeine concentrations of 1.75-2.0% recorded no germination compared with more than 90% germination at the end of the 7 days recorded in the case of 0.05-0.25% caffeine concentrations. There was a reduction in radicle length as the caffeine concentration increased at 7 weeks after planting. 0.5% caffeine concentration recorded the highest shoot length of 3.32cm among the caffeine concentrations with no significant difference detected in the stem girth studied. From the results obtained therefore, lower caffeine concentrations showed an increase in Bambara groundnut germination, hence could result in general improvement in crop yield.
Keywords: Bambara nuts, Caffeine, Crop, Germination, *Vigna,* Yola

INTRODUCTION
Bambara groundnut (*Vigna subterranea*) belongs to family fabaceace, an annual leguminous crop. This crop plant has been grown and cultivated among the rural people of Higgi, Fali, Bura, Margi and Kilba (all in Adamawa State, Nigeria) on their marginal land with non-or little fertilizer. It has been reported as one of the underutilized crops of Africa, which have been cultivated for centuries (Heller *et al.,* 1997) and a highly nutritious crop plant that plays a crucial role in people's diets (Ambede *et al.,* 2012). Empirical evidence and the result of specific studies indicate the considerable potential of these underutilized crops (Lawal *et al*., 2007). There is evidence that demonstrates the resilient of the crop to adverse environmental conditions such as poor soil fertility and low rainfall pattern (Azam-Ali *et al*., 2001). Abiotic stress such as drought, salinity and toxic chemical substances have been established as the major environmental issues affecting crop plants productivity (Alam *et al.,* 2004).

Caffeine (1, 3, 7-trimethylxanthine) can be found in coffee, tea and some class of energy drinks. A significant number of people consumed the various amount of caffeine daily. The well-established impact of caffeine upon strip muscle and its effect on plant cells, show that it has a disintegrating effect upon certain vegetable and animal proteins (Ransom, 1912). The mutagenic effect of caffeine was detected on *Ophiostoma multiannulatum* by Fries and Kihlman (1948). It was also found to be a weak mutagenic in *E. coli* by inducing back mutations (Gezelius and Fries, 1952).
It has been observed that caffeine also can act synergistically in inducing chromosomal aberrations in mammalian cells (Kato, 1973). The main objective of this study therefore, is to fine out the effects of different caffeine

concentrations on the germination of Bambara groundnut (*Vigna subterranea*).

MATERIALS AND METHODS

The seeds of Bambara groundnut (*Vigna subterranea*) were purchased from Jimeta Modern Market, Yola, Nigeria. Healthy looking seeds were selected for the purpose of this study. The seeds were pre-soaked in distilled water for 12hours and then exposed to the different concentrations of the caffeine doses prepared on weight basis,i.e. 0 %, 0.05 %, 0.25 %, 0.5 %, and 0.75 % 1.0 %, 1.25 %, 1.5%, 1.75% and 2.0% w/w caffeine in solution, prepared in a phosphate buffer of pH-7. This was done by measuring appropriate grams of caffeine and dissolved in 100 ml of distilled water. Distilled water only (without caffeine) represented as 0 % was used as control. After exposure to different caffeine concentrations for 24 hours, the seeds were gently rinsed in running tap water to reduce the excess caffeine. Three replications of each treatment were made after which the seeds were sown to raise the M_1 generation using Complete Randomized Block Design (CRBD). Parameters taken include number of days after germination initiation, radicle length, shoot height, and stem girth

Statistical analysis

Quantitative data obtained were subjected to One-way Analysis of variance (ANOVA). Significant means were separated using Duncan Multiple Range Test (DRMT) at P≤0.05 by means of SPSS software version 17.0

RESULTS

Percentage germination at the first day after initiation was 10% in the 0.05% treatment, whereas it was 0% in control (Figure. 1). However, 7 days after germination initiation, germination was 65.7% in control, compared to 27.1% in 0.05 treatment and 2.86% in 1.75 treatment. Germination was observed to be affected negatively with increased concentration of the treatment. No germination was observed at 2.0% concentrations of caffeine.

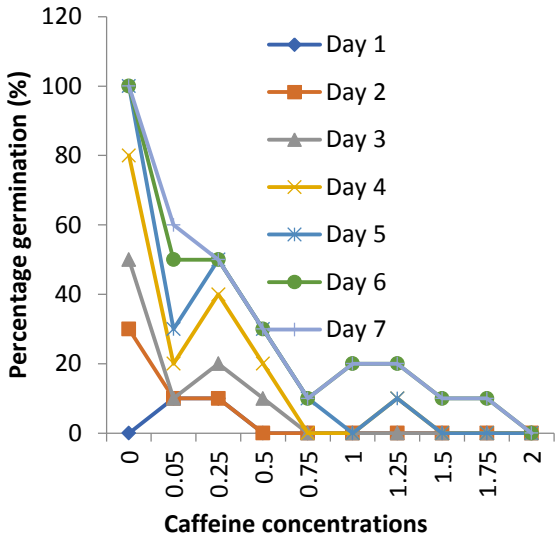

Figure 1: Graphical presentation of the effects of different concentrations of caffeine on the germination of Bambara groundnut.

Radicle length of seed after germination is shown in Figure 2. On the 7th day, the longest radicle measuring 2.0 cm was that of the control, compared to the radicles of treated seeds which ranged from 1.01 – 1.08 cm.

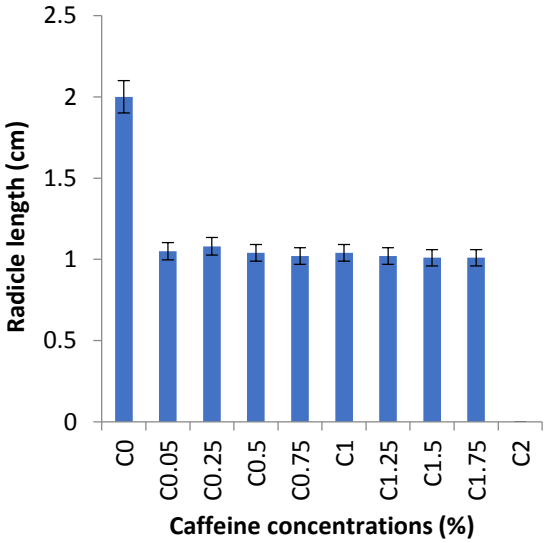

Figure 2: Effects of different caffeine concentrations on the radical length of Bambara nut 7 days after germination

Shoot length at day 7 of germination initiation ranged from 1.54 – 3.23 cm in the caffeine treated seeds as compared to 4.35 cm in control (Figure 3). Considering the results

obtained from both figure 2 and 3, it could be noticed that Bambara nut seedlings treated with caffeine concentrations were lower in radicle and shoot length compared to the control.

DISCUSSION

The lowest caffeine concentration (0.05%) at 7 days after planting recorded 60% germination, an increase in caffeine concentration led to reduced rate of germination of the treated seeds. At this concentration of 0.05%, germination is said to be triggered while higher concentrations delayed the germination rate. This is synonymous with the report of Mshelmbula *et al.* (2012) on the effect of another chemical agent called sodium azide on cowpea. They observed that increased in sodium azide concentration led to a reduction in germination rate in cowpea. Our result also agrees with Khursheed *et al.,* (2009) who reported that lower doses of caffeine exacted stimulatory influence on growth and yield of *Helianthus annuus* and vice versa. Mensah *et al.* (2007) also reported that increased in the concentration of sodium azide and colchicine reduced the germination rate in *Sesame indicum L*.

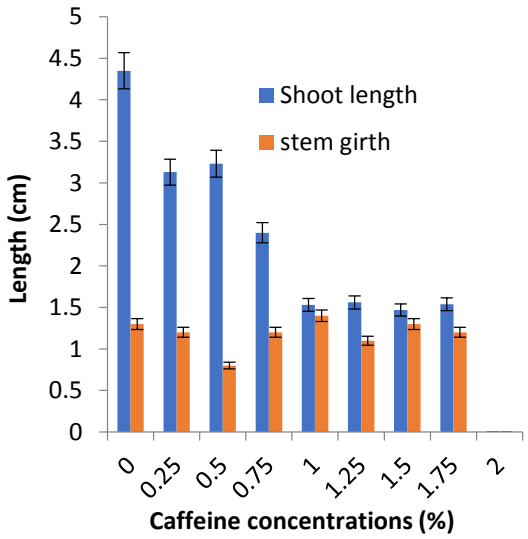

Figure 3: Effects of different caffeine concentrations on the shoot height and stem girth of Bambara groundnut.

In this study, it was evident that caffeine at lower concentrations had little effects on germination rate and longer radicle length. This was also found in other studies. For example, caffeine positlvely influenced the plant height of *Capsicum annuum* at lower doses while higher doses were observed inhibitory (Kumar and Tripathi 2004).

Also 0.5% caffeine concentration recorded the highest shoot length of 3.32cm and the length reduced with increased caffeine concentrations. There was however no significant difference in the stem girth among all the concentrations studied. It is noteworthy to say that lethality was observed at the highest caffeine concentration of 2%.These findings correlated with the result of Khursheed *et.al*., (2009) on the effects of caffeine on *Helianthus annuus L*. This finding suggests that caffeine at a lower concentration may lead to higher cellular activities that can propel an increase in shoot height. The positive effects of other chemical mutagens on shoot length of groundnuts have been also been reported (Mshelmbula *et al*. 2015; Mensah and Abodani 2007).

CONCLUSION

The effects of caffeine on growth parameters of bambara nut was found to be concentration dependent. The higher the concentrations of caffeine, the more negative the corresponding effects on the growth of bambara nut.

REFERENCES

Alam, M.Z., Stuchbury, T., Naylor, R.E.L. and Rashid, M.A. (2004). Effect of salinity on growth of some modern rice cultivars. *Journal of Agronomy*, **3**:1-10

Ambede, J. G., Netondo, G. W., Mwai, G. N. And Musyimi, D. M. (2012). NaCl salinity affects germination, growth, physiology, and biochemistry of bambara groundnut. *Brazilian Journal of Plant Physiology*, **24**(3): 151-160.

Azam-Ali S.N., Sesay A., KarikariS. K., Massawe, F.J., Aguilar- manjarrez,J., Bannayan, M. and Hampson, K.J. (2001). Development of microsatellite markers for Bambara groundnut (*Vigna subterranean* L. Verdc.) – an underutilized African legume crop

species.*Molecular Ecology Notes,* **7**: 1326 – 1328

Fries, N.and Kihlman, B. (1948). Fungal mutations obtained with methyl xanthines. *Nature*, **162**(4119): 573-574.

Gezelius, K. and Fries, N. (1952). Phage resistance mutants induced in *E. coli* by caffeine. *Heriditas,* **38**: 112

Heller, J., Begemann, F. and Mushonga, J. (1997). Bambara groundnut (*Vigna subterranean* (L.)Verdic. In: Proceedings of the workshop on the conservation and improvement of bambara groundnuts (*Vigna subterranean* (L.) Verdic. Harare, Zimbabwe

Kato, H. (1973). Induction of sister chromatid exchanges by UV light and its inhibition by caffeine.*Experimental cell research*, **82**(2): 383-390.

Khursheed, T. Ansari, M.Y.K. and Shahab, D. (2009). Studies on the effect of caffeine on growth and yield parameters in *Helianthus annuus* L. variety. Modern Biology and Medicine, **1**(2): 56-60

Kumar, G. and Tripathi, A. (2004). Mutagenic response of caffeine in *Capsicum annuum* L. *Journal of Indian Botanical Society*, **83**: 136-140.

Lawal, S. O., Adebowale, K. O. and Adebowale, Y. A. (2007).Functional properties of native and chemically modified proteins concentrates from bambarra groundnut. *Journal of Food Research International,* **40**:1003–1011.

Mensah, J. K., Obadoni, B. O. 1 Akomeah, P. A.1, Ikhajiagbe, B. and Ajibolu, Janet (2007). The effects of sodium azide and colchicine treatments on morphological and yield traits of sesame seed (*Sesame indicum L*.) *African Journal of Biotechnology* **6**(5):534-538.

Mensah, J. K. and Obadoni, O. (2007). Effects of sodium azide on yield parameters of groundnut (*Arachis hypogea L*.). *African Journal of Biotechnology*, **6**: 20-25.

Mensah, J. K., and Obadoni, B. (2007).Effects of sodium azide on yield parameters of groundnut (*Arachishypogaea* L.). *African journal of Biotechnology*, **6**(6):534-538

Mshelmbula, B.P., Mensah, J.K and Ikhajiagbe, B. (2012).Comparative assessment of the mutagenic effects of sodium azide on some selected growth and yield parameters of five accessions of cowpea – Tvu-3615, Tvu-2521, Tvu-3541, Tvu-3485 and Tvu-3574. *Archives of Applied Science Research.***4**(4):1682-1691.

Mshelmbula, B.P., Gloria,O., Mensah, J.K., Ikhajiagbe, B. and Rebecca,Z. (2015). The Effects of Indole-3 Acetic Acid (IAA) on the Growth and Yield of Sesame (Sesamumindicum L.) under Drought Condition. *International Journal of Science and Knowledge,* **4**(1): 60-65.

Ransom, F. (1912). The effects of caffeine upon the germination and growth of seeds.*Biochemical Journal*, **6**(2): 151-156.