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GROWTH AND DRY MATTER YIELD RESPONSES OF COWPEA TO DIFFERENT SOWING DEPTHS

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ABSTRACT

The depth of sowing has an important impact on the seedling emergence, growth and yield of crops. Uniform seeding depth is essential toward achieving higher crop yields. The objective of this study was to compare the effect of different depths of sowing on cowpea (Vigna unguiculata (L.) Walp.) Seedling emergence, plant height, stems girth, number of leaves per plant, and dry matter yield. Asontem cowpea variety was sown in a loamy sand soil at five different sowing depths (20, 30, 50, 70 and 90mm) replicated three times in a randomised complete block design at two seeds per hill in 1.8m x 1.8m plots with spacing between plants and rows of 20 and 60cm, respectively. Plant stand was counted daily on each plot after the first seedling emerged until a stable count was obtained to determine the percentage emergence. Plant height, stem girth, and number of leaves were measured once a week for 7 weeks after the first plant emerged. The dry matter yield was determined 65 days after planting. Sowing depth effects were generally not significant. However, sowing at 50mm produced the highest percentage cowpea seedling emergence, plant height, stem girth, number of leaves and dry matter yield compared with sowing at 20, 30, 70 and 90mm. The study showed that for optimum growth and yield of cowpea, sowing should be done at a depth of 50mm.

Keywords: cowpea, sowing depth, seedling emergence, plant growth, dry matter yield.

INTRODUCTION

Cowpea (Vigna unguiculata L, Walp.) is an important food legume grown under rain-fed conditions in the tropics (Sangakkara, 1998). Although it occupies a smaller proportion of the crop area than cereals, cowpea contributes significantly to household food security in West and Central Africa (Baur, 1992 cited by Langyintuo et al. 2004). It is an important component of sustainable cropping systems in Ghana. Cowpea fixes atmospheric nitrogen up to 240 kg/ha and leaves about 60-70 kg nitrogen for succeeding crops (CRI, 2006a). In Ghana, cowpea is grown largely by resource poor smallholder farmers under rain-fed conditions with the aid of cutlass, hoe or dibbler. One of the problems of using these hand tools is that they produce depths of sowing significantly different from 50mm (Aikins *et al.* 2006). Sowing depth is an important factor in crop management practices (Campbell *et al.* 1991; Kirby, 1993 cited by Mahdi *et al.* 1998). The depth of sowing is important in achieving higher crop stand establishment and yield. The main objective of seeding is to put seeds at a desired depth and spacing within the row. Uniform distribution of seeds within the soil results in better germination and emergence and increased yield by minimising competition between plants for available light, water, and nutrients. Optimum seeding depth control is generally viewed as a desired goal for all crop establishment systems (Karayel and Özmerzi, 2008). Too shallow sowing results in thin germination due to inadequate soil moisture at the top soil layer. On the other hand, deep sowing (e.g. beyond 60mm) can significantly affect crop emergence and yield (Aikins *et al.* 2006; Desbiolles. 2002; Mahdi et al., 1998; Photiades and Hadjichristodoulou. 1984). Mullen *et al.* (2003) suggest that cowpeas should be sown at 100 mm depth. For good germination cowpea should be sown at 25-38 mm (Valenzuela and Smith, 2002). According to Whitbread and Lawrence (2006) and CRI (2006b), cowpea should be sown at a depth of 30-50 mm.

There is limited documentation on the effect of depth of sowing on cowpea establishment, growth and yield in Ghana. Such information is useful and helps to provide agricultural extension delivery to farmers for increased crop productivity and poverty alleviation. The objective of this study was to compare the effect of different depths of sowing on cowpea seedling emergence, height, stem girth, number of leaves, and dry matter yield.

MATERIALS AND METHODS

Site description

This study was conducted between March and June, 2008 during the major cropping season at the field near the Plantation Section of the Department of Crop and Soil Sciences, Faculty of Agriculture at Kwame Nkrumah University of Science and Technology, Kumasi, Ghana (latitude 6° 43’ N, longitude 1° 36’ W). The field has a gentle slope and is well drained. The rainfall pattern is bi-modal from March to July and from September to November, when most of the rain falls as heavy convectional storms, followed by a dry season from November to March. The area has an average rainfall of about 1300mm. The experiment was carried out on a loamy sand soil with characteristics presented in Table-1.

The field had been cropped with groundnut for two years before the experiment was started. The experimental field was disc ploughed on 22 March 2008 and disc harrowed on 2 April 2008.

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Table-1. Selected physical and chemical properties of the soil at the Experimental Site.

Soil properties	**Soil depth** (cm)	
	0-15	15-30
Sand (%)	84.4	84.4
Silt (%)	3.6	7.6
Clay (%)	12.0	8.0
Organic matter	0.7567	1.1694
Organic carbon (%)	0.4389	0.6783

Experimental design

The experiment was set up in a completely randomized block design with five sowing depth treatments (20, 30, 50, 70 and 90mm) and three replicates. Single plots were 1.8m x 1.8m in size. All plots were separated by a 1.5m buffer zone. Asontem cowpea variety was manually sown on 2 April 2008 in moist soil with a depth controlled dibbler at 0.60m row spacing and intra-row spacing of 0.20m at a density of 54 plants per plot corresponding to 166,667 plants ha^{-1}.

Crop growth and yield parameters

Plant population counts were taken daily on each plot after the first seedling emerged until a stable count was obtained. The percentage seedling emergence was obtained by dividing number of emerged seedlings at any time by the total number of seeds sown, multiplied by 100. Five plants were selected per plot at random and tagged for determination of plant height, stem girth, and number of leaves per plant at weekly intervals for 7 weeks starting 10 days after planting (i.e. one week after the first plant emerged). Plant height was measured using a meter rule. Stem girth was measured using a thread, ruler and a vernier calliper. The numbers of leaves of the five tagged plants per plot were counted at weekly intervals. The dry matter yields were determined by manually harvesting four cowpea plants per plot at 65 days after planting (DAP). The plants were washed and cleaned to remove traces of soil before oven drying them at 70^{o}C for 48 hours and then put on a top loading balance to determine their dry weights.

Good weed control is essential for high-yielding cowpeas. Weeding was accomplished using a hand hoe at 3 and 6 weeks after sowing. Cowpea plants were sprayed against insect pests using a non-systemic contact insecticide (RAMBO 2.5 EC) containing 25g of Lambda cyhalothrin per litre at a rate of 600mls/ha at 2, 5 and 8 weeks after planting (WAP), respectively.

Statistical analysis

The effects of depth of sowing on seedling emergence, plant height, stem girth, number of leaves, and dry matter yield were determined using analysis of variance (ANOVA) with the aid of the statistical software, MINITAB Release 13.1 (MINITAB Inc. 2000). A significance level of 0.05 was used for all analyses.

RESULTS AND DISCUSSIONS

Figure-1 Shows the mean percentage seedling emergence of the cowpea plants for each depth of sowing. The results were not statistically significant between the different sowing depths. However, it can be seen that over the period of the experiment, plants in plots where the sowing depth was 50mm had the best percentage seedling emergence, followed by 30mm, 20mm, and 70mm sowing depth. The worst percentage seedling emergence was with the 90mm sowing depth. Poor emergence with the 90mm was probably the result of sowing depth being too deep. This observation is consistent with that of Aikins *et al.* (2006) and Desbiolles (2002) that deep sowing (e.g. beyond 60mm) can significantly affect crop emergence and yield.

Emergence is probably the single most important event that affects the success of an annual crop. Rapid, uniform and complete emergence of vigorous seedlings, leads to high grain yield potential by shortening the time from sowing to complete ground cover, allows the establishment of optimum canopy structure to minimise interplant competition, maximise crop yield and provide plants with time and spatial advantages to compete with weeds (Soltani *et al*. 2001 cited by Soltani *et al*. 2006).

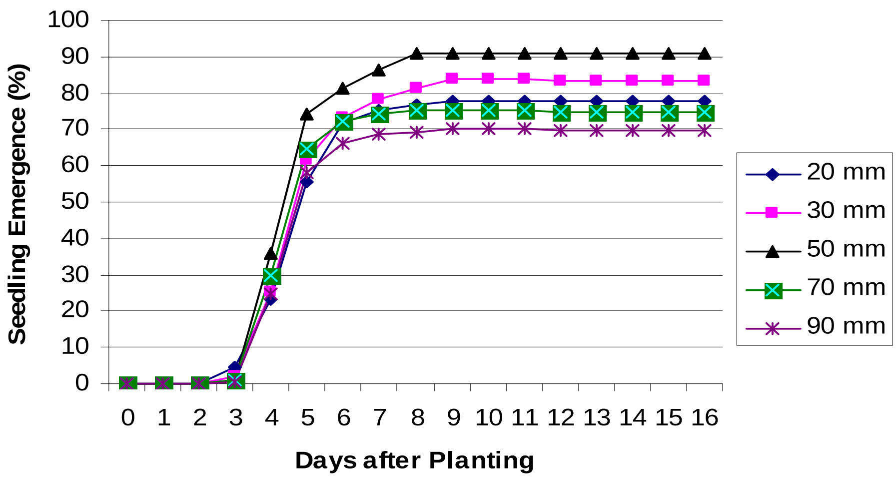

Figure-1. Effect of sowing depth on percentage seedling emergence.

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Height of plants

Figure-2 illustrates the effect of sowing depth on mean values of plant height over the period of the experiment. Analysis of variance showed no significant effect of sowing depth on plant height. However, plots with the 50mm sowing depth had the tallest plants followed by the 30mm, 20mm, and 70mm. The shortest plants were found in the 90mm sowing depth plots. It is assumed that the too deep sowing probably prevented the seedlings from pushing their shoots above through the thick soil layer initially leaving the other treatments the opportunity to establish faster. Sowing cowpea at shallow depth (20mm) also reduced plant height probably because of inadequate soil moisture at the top soil layer.

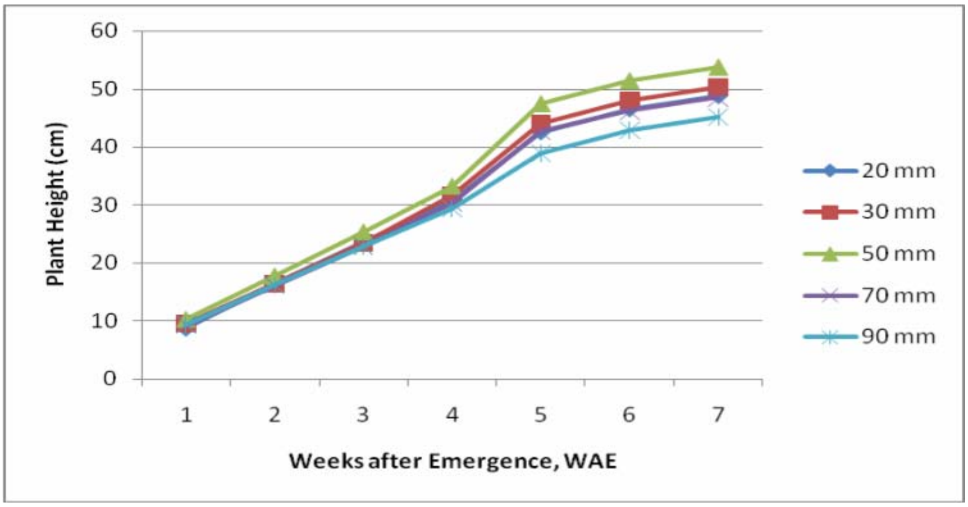

Figure-2. Effect of sowing depth on plant height.

Stem girth of plants

Figure-3 presents the mean values of plant stem girth during the experimental period. No statistical differences in stem girth were found between sowing depth treatments. For all sowing depths, the stem girth for the 50mm sowing depth plots was greatest. This was followed by the 30mm, 20mm, and 70mm. Plants with the smallest stem girth were found in the 90mm sowing depth plots. Seven weeks after emergence, sowing at 50mm increased the stem girth by 5% and 4% compared with the 90mm and 70mm treatments, respectively.

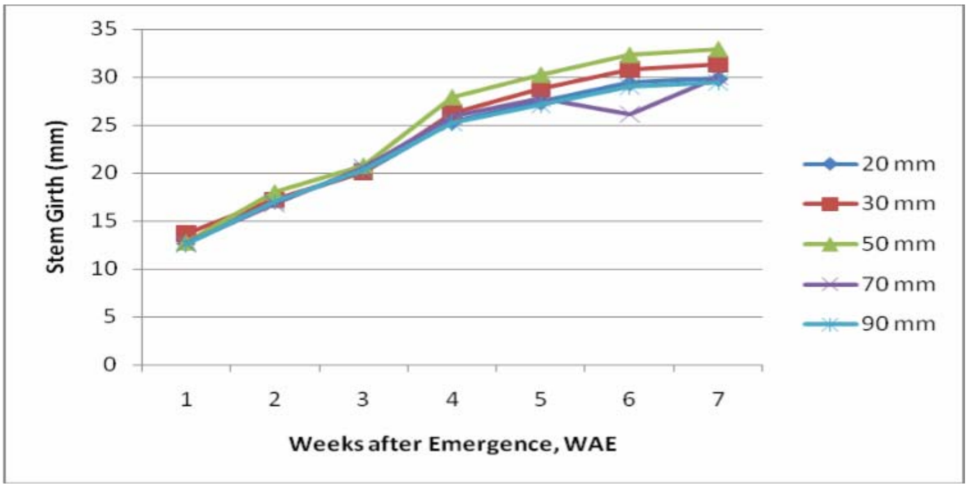

Figure-3. Effect of sowing depth on stem girth.

Number of leaves

Figure-4 portrays the mean plant number of leaves during the experimental period. It can be seen that the 50mm sowing depth presented the highest number of leaves per plant compared with the 20, 30, 70 and 90mm sowing depths. The minimum number of leaves per plant was observed in the 90mm sowing depth plots.

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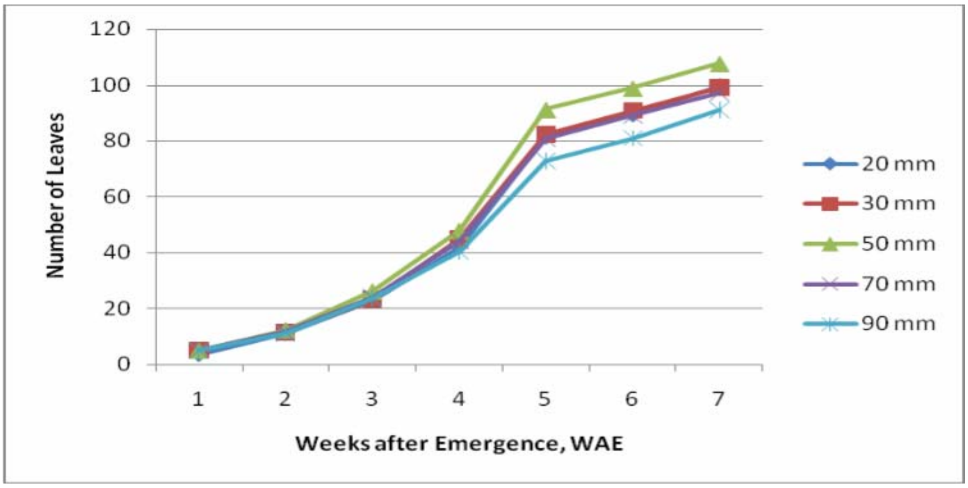

Figure-4. Effect of sowing depth on number of leaves.

Seven weeks after emergence, the mean plant number of leaves varied from a maximum of 107.67 with the 50mm sowing depth to a minimum of 91.27 with the 90mm sowing depth, a decrease in number of leaves per plant of 15.2%. However, there was no statistical significant difference ($p = 0.05$) in number of leaves per plant between the five different sowing depths.

Dry matter yield

Dry matter yields of cowpea at 65 DAP at different sowing depths are presented in Table-2. These results show that the dry matter yield of cowpea was not significantly affected by the five different sowing depths. The highest yield, 3429 kg/ha, however, was obtained from plots sown at 50mm followed by 30mm, 20mm and 70mm. The least dry matter yield, 1464 kg/ha (less than twice that of the 50mm sowing depth) was obtained from the deepest sowing depth, 90mm.

Table-2. Mean cowpea dry matter yield.

Sowing depth (mm)	**Dry matter yield** (kg/ha)
20	2581
30	2631
50	3429
70	1492
90	1464
LSD ($p = 0.05$)	NS

CONCLUSIONS

From the results the following can be concluded: Sowing depth affected mean seedling emergence, plant height, stem girth, number of leaves per plant and dry matter yield although there was no statistically significant difference between sowing depth treatments. Sowing at 50mm presented the best results in terms of cowpea seedling emergence, growth, and dry matter yield under the soil and weather conditions of the experiment.

Sowing at 30mm gave the second best results and can be used to give seedling emergence, growth, and dry matter yield statistically similar to the 50mm sowing depth. Sowing beyond 50mm presents the relatively lower seedling emergence, growth, and dry matter yield.

These results highlight the importance of uniform seeding depth for optimizing cowpea establishment and yield. Therefore a hand tool capable of sowing at a uniform depth should be developed and evaluated for consequent use by smallholder farmers in Ghana.

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REFERENCES

Aikins S.H.M., Afuakwa, J.J. and Baidoo, D. 2006. Effect of Planting Depth on Maize Stand Establishment. Journal of the Ghana Institution of Engineers. 4(2): 20-25.

Baur H. 1992. Farming systems in northern Ghana. Nyankpala Agricultural Experiment Station Report. Tamale, Ghana. p. 140.

Campbell C.A., Selles, F., Zentner, R.P., McLeod, J.G. and Dyck, F.B. 1991. Effect of seeding date, rate and depth on winter wheat grown on conventional fallow in S.W. Saskatchewan. Can. J. Plant Sci. 71: 51-61.

CRI. 2006. Cowpea Production Guide: Introduction to Cowpea Production. Available online: http://www.cropsresearch.org/publications/pdf/cowpea_Introduction.pdf

CRI. 2006. Cowpea Production Guide: Planting the Crop. Available online:

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http://www.cropsresearch.org/publications/pdf/cowpea_Planting.pdf

Desbiolles J. 2003. Canola Response to Seeding Systems. YP ASG Annual Results Book 2003 - Growing Results for You. Available online: http://www.alkalinesoils.com.au/Trial_Results/Trial/Book/pdfs/2003/Soils_Seeding_systems/202003.pdf pp. 53-56.

Desbiolles J. 2002. Optimising Seeding Depth in the Paddock. Available online: http://www.unisa.edu.au/amrdc/Areas/Proj/SeedTrials/Seeding_depth_article_Kerribee.pdf

Karayel D. and Özmerzi A. 2008. Evaluation of three Depth Control Components on Seed Placement Accuracy and Emergence for a Precision Planter. Applied Engineering in Agriculture. 24(3): 271-276.

Kirby E.J.M. 1993. Effect of sowing depth on seedling emergence, growth and development in barley and wheat. Field Crops Research. 35: 101-111.

Langyintuo A.S., Ntoukam G., Murdock L., Lowenberg-DeBoer J. and Millera D.J. 2004. Consumer preferences for cowpea in Cameroon and Ghana. Agricultural Economics. 30: 203-213.

Mahdi L., Bell C.J. and Ryan J. 1998. Establishment and yield of wheat (Triticum turgidum L.) after early sowing at various depths in a semi-arid Mediterranean environment. Field Crops Research. 58(1): 187-196.

MINITAB Inc. 2000. MINITAB™ Statistical Software Release 13.1 for Windows, USA.

Mullen C.L., Holland, J.F. and Heuke, L. 2003. AGFACTS: Cowpea, lablab and pigeon pea. Available online: http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0006/157488/cowpea-lablab-pigeon-pea.pdf

Photiades I. and Hadjichristodoulou A. 1984. Sowing date, sowing depth, seed rate and row spacing of wheat and barley under dryland conditions. Field Crops Research. 9: 151-162.

Sangakkara U.R. 1998. Growth and Yields of Cowpea (Vigna ungukulata (L.) Walp) as Influenced by Seed Characters, Soil Moisture and Season of Planting. J. Agronomy and Crop Science. 180: 137-142.

Soltani A., Robertson M.J., Torabi B., Yousefi-Daz M. and Sarparast R. 2006. Modelling seedling emergence in chickpea as influenced by temperature and sowing depth. Agricultural and Forest Meteorology. 138(1-4): 156-167.

Soltani A., Zeinali E., Galeshi S. and Latifi N. 2001. Genetic variation for and interrelationships among seed vigor traits in wheat from the Caspian Sea coast of Iran. Seed Sci. Technol. 29: 653-662.

Valenzuela H. and Smith J. 2002. Cowpea, Sustainable Agriculture, Green Manure Crops CTAHR. Available online: http://www.ctahr.hawaii.edu/oc/freepubs/pdf/GreenManureCrops/cowpea.pdf

Whitbread A. and Lawrence J. 2006. Cowpea fact sheet for Grain and Graze. Available online: http://www.brgg.org.au/assets/docs/FactSheets/Cow_pea.pdf