ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 2, Issue 1, pp: (43-48), Month: January-March 2014, Available at: www.researchpublish.com

Inter-Relationships of Yield and Components of Yield at Different Stages of Maturity in Three Groundnuts (*Arachishypogaea L*) Varieties

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Abstract: **The subterranean nature of fruiting in groundnut (Arachishypogaea L) and its indeterminate growth habit makes it difficult to determine the time of maximum maturity of pods. The objectives of the study were to: determine the time to harvest groundnut for optimum yield of pods for varieties differing in flowering and maturity date, and estimate potential yield losses at different harvesting dates. Three groundnut genotypes ('Chinese', 'F-Mix' and 'Kpedevi') were harvested over a period of seven weeks. A split-plot design with four replications was used with the groundnut genotypes as main plots and the harvest dates as sub-plots. Data taken were: number of mature pods, number of immature pods, number of pegs, top shoot weight, days to 50% flowering and days to first flowering. The genotypes showed an increasing trend in the number of mature pods plant^{-1} as harvesting date delayed. Maximum mature pods of 27, 24, and 14 plant^{-1} was produced by 'Kpedevi', 'F-Mix' and 'Chinese' genotypes at 112, 105 and 98 DAS respectively. None of the three genotypes produced mature pods at 70 DAS. The number of immature pods and number of pegs were components of mature pods in the three genotypes. Top shoot reduction was an indicator of maturity in both 'Chinese' and 'F-Mix' genotypes but could result in yield loss due to late harvesting in 'Kpedevi'.**

Keyword: **Genotype, 'Chinese', 'F-Mix' and 'Kpedevi'**

1. INTRODUCTION

Groundnut (*Arachishypogaea L*) is the third largest oilseed crop after soybean and seed cotton globally. It is an important source of vegetable protein and oil in sub-Saharan Africa (Marfo*et al*., 1999). It contains good sources of vitamin E, niacin, folate and magnesium (Griel*et al.*, 2004).

The maturity period of groundnut varies in the maximum percentage of mature fruits at harvest (Young and Mason, 1972). Upadhyaya*et al*. (2006) reported that maintaining peanut germplasm requires harvesting at optimum maturity to obtain healthy seeds. Also, one of the most critical parts of growing peanut is timing of harvest to make maximum grade and yield (Wright *et al*., 2009).

Some farmers determine maturity and harvest their groundnut based on morphological features such as yellowing of foliage, dropping of older leaves, hard and tough pods (Tsigbey*et al*. 2001;Upadhyaya, 2006). Also, Jordan *et al*. (2008) indicated that digging peanut based on pod mesocarpcolor continuesto be effective in optimizing market grade characteristics. However, the subterranean nature of fruiting in groundnut makes it difficult to determine maximum maturity of pods using only morphological features; also, groundnut has indeterminate growth habit, which ensures that pods are produced at every stage

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of its growth (Jordan *et al*., 2005; Jordan, 2006a). This poses a challenge in determining how to balance the continuous production of immature pods and earlier formed pods in terms of when to harvest. Delay in harvesting after physiological maturity can result in many pods left in the soil due to weakening of pegs (Singh and Oswalt, 1995). Also, late harvesting may expose the crop to field pests which cause substantial loss. Yield loss due to termites, which predominantly damaged harvested kernels was estimated at 10 to 30 % (Umeh*et al*., 1999). Pod losses due to *in situ* sprouting of seed are substantial (20 -30 %) during late harvesting (Nautiyal*et al.,* 2001). Also, premature harvesting of groundnut pods lower the yield, oil content and seeds quality due to immature pods and seeds (Singh and Oswalt, 1995). Wright and Porter (1991) further indicated that harvesting groundnut too early can reduce yield by 15% and economic value by 21%. This therefore creates the need to harvest the groundnut plant at an appropriate time in order to reduce yield losses. The objectives of this study were therefore to: determine the time to harvest groundnut for optimum yield of pods for varieties differing in flowering and maturity date and estimate yield losses at different harvesting dates.

2. MATERIALS AND METHODS

Two field experiments was conducted at the University of Ghana farm, Legon(5 ° 58 ’ N, 0 ° 8 ’ W; 153 m above sea level). The experimental site is within the coastal Savannah zone, with annual mean rainfall of 750 mm and average temperature of 26 ° C. The soil belongs to the Adenta series, ferric Acrisol (FAO, 1990). Three local varieties of groundnut: ‘Chinese’, ‘Kpedevi’ and ‘F-Mix’ were evaluated during the study. The experiment was laid out in a split-plot design with four replications. The cultivars were the main plots whilst the harvesting dates were the subplots. The plant spacing was 45cm x15cm. Harvesting was carried out from 70 DAS until 112 DAS. At each harvest date, five plants were harvested from a plot. From 10^{th} to 16^{th} week, the following data were collected: Top dry weight; Number of mature pods, Number of immature pods, Number of pegs, Dry pod weight, Days to first flowering and50% flowering.

3. RESULTS

3.1 Pegs and pods production

There were significant differences ($P < 0.05$) in the number of mature pods among the varieties. The ‘Kpedevi’ variety harvested at 112 DAS had the highest mean of 27 pods plant $^{-1}$ whilst ‘Chinese’ and ‘F-Mix’ varieties produced 14 and 24 pods plant $^{-1}$ at 98 DAS and 105 DAS respectively. None of the genotypes produced mature pods at 70 DAS (Figure 1).

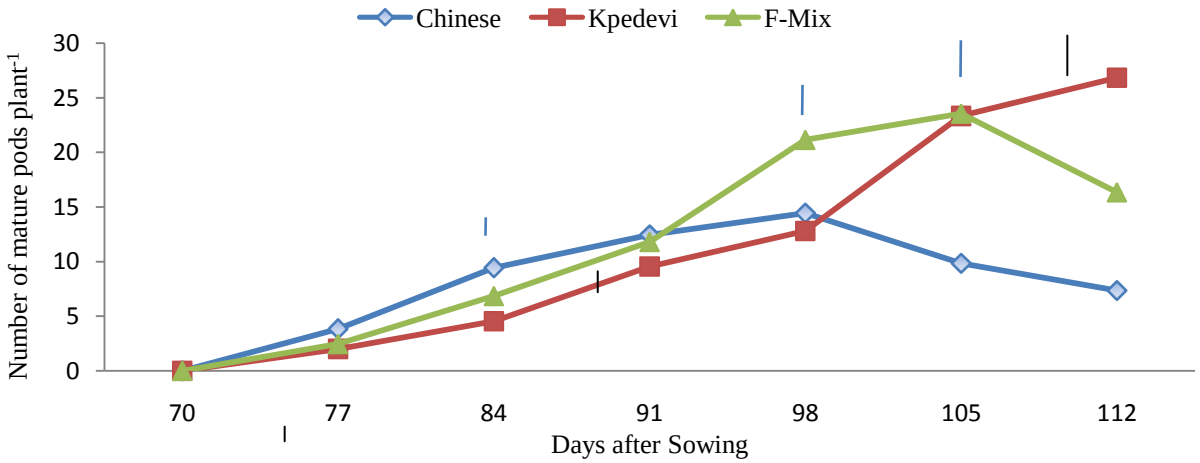

Figure 1: Number of mature pods at different harvest dates for the three genotypes.(Bars represent least significant difference values)

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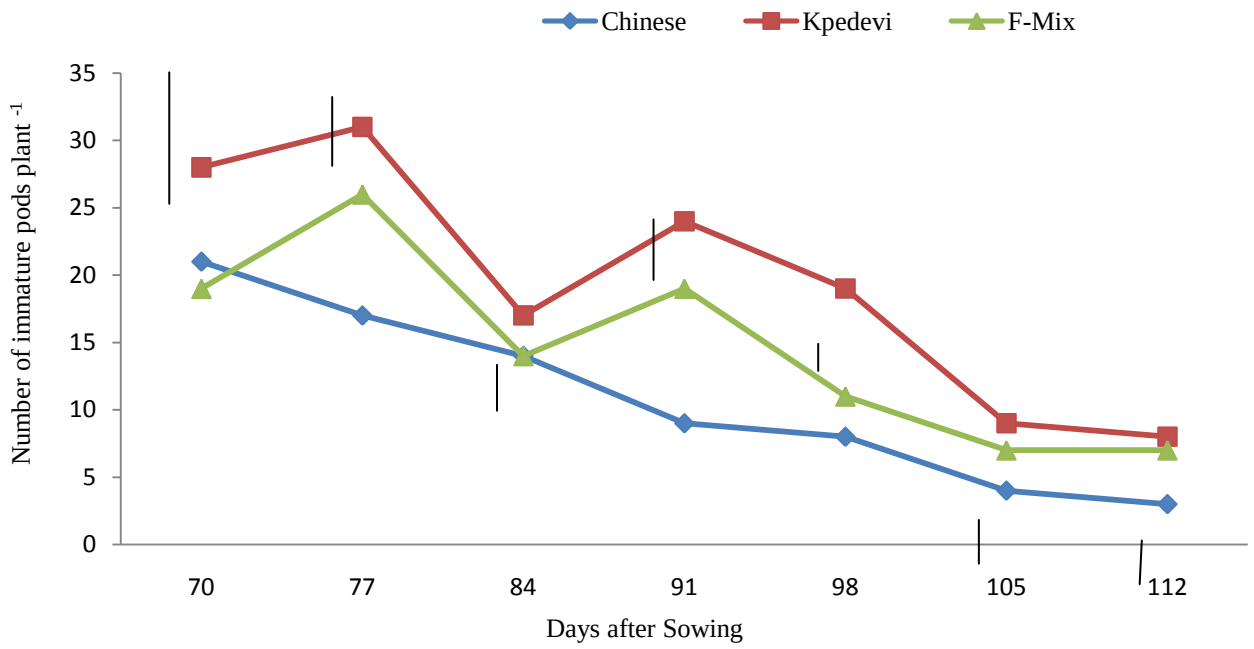

Figure 2: Number of immature pods of the three groundnut genotypes. (Bars represent least significant difference values)

All the three varieties showed similar trend in the number of immature pods development. At 70 DAS, 'Chinese' variety produced the highest number of immature pods plant^{-1}(21 pods) though this was not significantly different from both 'Kpedevi' and 'F-Mix' varieties (Figure 2). Except at 77 DAS, there was significant difference ($P < 0.05$) in the number of pegs plant $^{-1}$ among the three groundnut varieties (Figure 3).

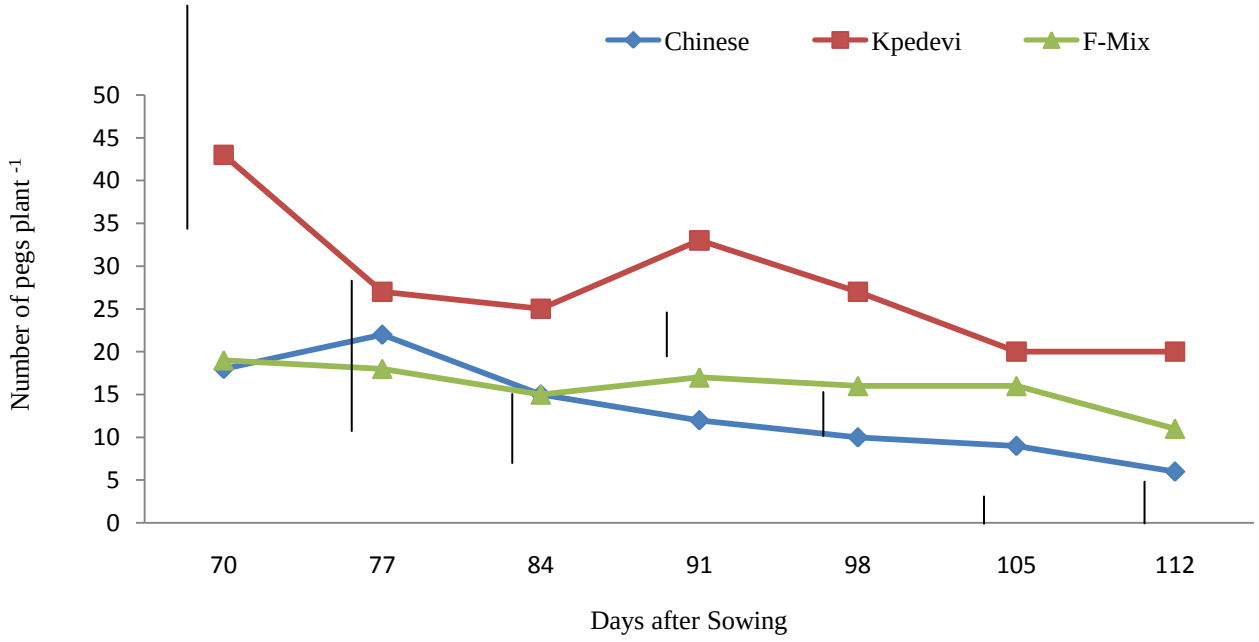

Figure 3: Number of pegs of the three groundnut genotypes (Bars represent least significant values)

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3.2 Top dry weight at different stages of maturity and harvest

Except harvest at 77 DAS and 84 DAS, top dry weight showed significant difference ($P < 0.05$) among the three varieties. Among the harvest dates, 112 DAS recorded the lowest top dry weight in the three genotypes (Figure 4).

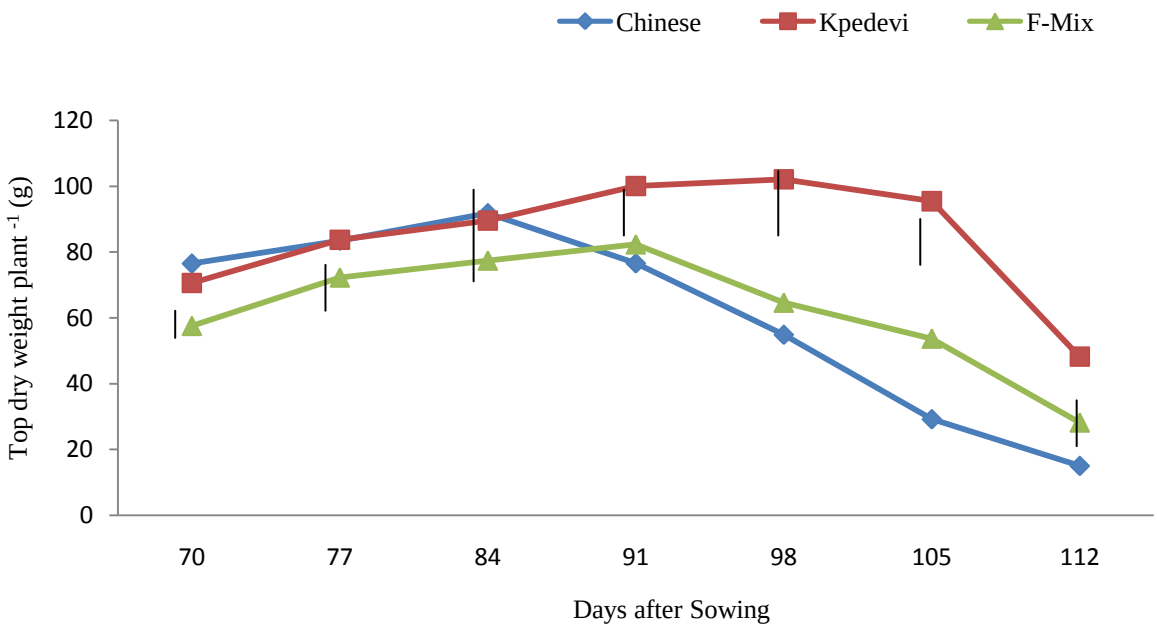

Figure 4: Top dry weight (g) of the three groundnut genotypes (Bars represent least significant difference values)

4. DISCUSSION

4.1 Effects of harvesting dates on pod maturity and yield

The subterranean nature of fruiting in groundnut and its indeterminate growth habit ensures that pods are produced at every stage of its growth making it difficult to determine the time of maximum maturity of pods (Jordan, 2006a). The significant increase at a stage in the number of matured pods plant^{-1} in all the three groundnut genotypes as harvesting date delayed suggests that groundnut after anthesis (60 to 70 DAS) will continue to produce mature pods until it reaches a maximum stage where decline could result. Patte*et al*. (1980) also reported that with some cultivar yield increased at late harvest dates whilst yield of other cultivars reached a peak and then began to decline.

Duncan *et al*. (1978) and Williams (2000) suggested that the length of the pod filling period and the rate of pod establishment best explain the variation in peanut yield. In this study, the maximum number of pod maturity for 'Chinese', 'F-Mix' and 'Kpedevi' were 14, 24, and 27 at 98, 105, and 112 DAS respectively, indicating variation in number of days to pod maturity among the different genotypes. However, there were still an increasing number of mature pods in 'Kpedevi' genotype at 112 DAS indicating that this genotype could be harvested after 112 DAS, possibly between 112-120 DAS. This confirms the hypothesis that the Spanish cultivar type will mature sooner (90 to 120) whilst Virginia (runner) genotypes requires 130 to 150 days to reach maturity (Knauft and Gorbet, 1989; Putman *et al*., 1991).The 'F-Mix' genotype is a Virginia type but there was a decline in pod maturity after 105 DAS, likewise the 'Chinese' genotype at 98 DAS. Suggesting that losses could result

in these genotypes if harvesting is delayed after maximum pod maturity. This agrees with Singh and Oswalt (1995) when they indicated that premature harvesting of groundnut pods lower the yield, and delay in harvesting after physiological maturity can result in many pods left in the soil due to weakening of pegs.Beasley (1990) stated that mature, harvestable pods require 60 to 80 days of development and peanut may gain in yield during the 10 to 14 day period preceding optimum digging time, and conversely, similar yield losses can occur if digging time is delayed 1 to 2 weeks. However, except for 'F-Mix' genotype, the result was contrary to this finding since 'Chinese ' and 'Kpedevi' showed significantly higher yield losses when harvested after 10 to 14 day period (84 DAS and 91 DAS respectively) preceding their optimum digging time, from 9 to 14 pods plant^{-1} in 'Chinese' and 13 to 27 pod plant^{-1} in 'Kpedevi'. Also, 'Kpedevi' did not show pod losses after harvesting was delayed 1 to 2 weeks but rather showed increasing pod number even at 112 DAS (16 weeks). Both 'Kpedevi' and 'F-Mix' which are Virginia types conform to the findings of Wright *et al.* (2009) who reported that Virginia type varieties normally mature in approximately 103 to 120 DAS. It is estimated that pods take about 8 weeks (56 days) to mature from the time of flowering (Lim and Hamdan, 1984). In agreement; no mature pods were produced at 70 DAS. There was a significant decrease in number of immature pods plant^{-1} as harvesting delayed among the three groundnut varieties. The 'Chinese' variety showed a continuous decrease (from 70 DAS to 112 DAS); however, at 84 DAS both 'Kpedevi' and 'F-Mix' had a decline and afterwards a gradual increase. Similar observation was recorded for the number of pegs plant^{-1}. This could possibly be as a result of an increase in the number of pegs immediately after anthesis which had a linear relationship with pod formation. The differences in peg and pod formation among the varieties could be attributed to inherent variation since they were all grown under similar environmental conditions, harmonizing an earlier report that groundnut cultivars vary by number of pegs and pods formed (Bell *et al*., 1991). Also, harvesting date with maximum mature pods did not necessarily have more pegs. This confirms Gilman and Smith (1977) findings that differences among groundnut varieties in rate of peg exertion were apparent but were not associated with maximum percentage of mature fruit.

5. CONCLUSION

The genotypes varied in their maturity date. The 'Chinese' and 'F-Mix' matured at 98 and 105 DAS respectively. 'Kpedevi' genotype could be harvested after 112 DAS without yield loss. Yield losses due to sprouting and weak peg strength may result when top shoot weight reduction is used as indicator of maturity in 'Kpedevi'.

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