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EFFECT OF PHOSPHORUS FERTILIZER LEVELS AND PLANT DENSITY ON GROWTH AND YIELD OF FINGER MILLET IN KURIA WEST SUB-COUNTY

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ABSTRACT

Finger millet (*Eleusinecoracana*) is an important crop that contributes greatly to income and food security of the smallholder farmers in rural areas in Africa and Asia. The production of this crop has been declining due to reduced area under cultivation and loss in soil fertility. The objective of this study was to find out the effect of different levels of phosphorus fertilizer and plant density on the performance of finger millet.The experiment was setup with Randomized Complete Block Design with treatments being phosphorus levels of Triple Supper Phosphate (TSP) (0, 25, 50 and 75 Kg/ha) and spacing in centimeters, S1 (30X10), S2 (30X15) and S3 (30X20). The experimental field was divided into 3 by 3 meters and replicated twelve times and three blocks. The experiment was conducted in two seasons, the first season seeding was done 21st November 2014 which is a short season and the second season planting was done on 23rd June 2015 this is a long rain season. Data was collected on growth and performance indicators like plant height, seed weight, length of the heads and number of fertile tillers was determined. Results indicated that plant density and phosphorus levels had significant effects on finger millet seed weight, number of fertile tillers, plant height and percentage lodging. It was found out that spacing and phosphorus levels affect the performance of finger millet in terms of tillering ability, growth and yield. The interaction between spacing and fertilizer levels in season one had a significant effect on finger millet height. The contribution of phosphorus to the size of the head length of finger millet appeared to be higher than that of plant density in both seasons.

INTRODUCTION

In Kenya, agriculture forms the backbone of this economy. Agriculture is central to the Government's development strategy. More than 75 percent of Kenyans earn a part of their living from agriculture. The sector also accounts for more than half of the country's gross domestic product(GOK, 2008). These sector accounts for 65 percent of Kenya's total exports Therefore, the sector is not only the driver of Kenya's economy, but also the means of livelihood for the majority of the Kenyan people (world bank, 2015).

In the recent years, Kenya has been facing severe food insecurity problems (FAO, 2004).The Government of Kenya responded to the food crises through a major policy intervention likeSubsidy on farm inputs, especially fertilizers.

Fertilizer use, along with other complementary agricultural inputs, is expected to play a vital role in transforming traditional agriculture and acceleratingagricultural growth. However, the present level of agricultural growth and fertilizeruse are extremely low and fluctuating. In many cases the growth infertilizer use is even negative. Accelerating the economic use of fertilizerwould require appropriate technology and major policy reforms (Mohinder, Uzo, & Paul, 1985).

Despite all the efforts from the government, agricultural productivity is stagnating while Kenya's population is rapidly growing posing critical challenges to food security (FAO, 2004). Small farms occupy a large share of Kenya's agricultural land therefore to increase food production policies should be directed to them. Most farmers work without basic agricultural inputs or updated technology and lack adequate financial or extension services.

According to the International Fund for Agricultural Development (IFAD), global food production will have to increase by 70% until 2050 in order to achieve global food security (IFAD, 2010).

Due to increasing population, climate change, water scarcity and soil depletion, prospects of bringing new land into agricultural production are limited. In order to meet the demand for agricultural products, radical changes in production and consumption have to be implemented. These will include the change in the eating habits and the production of bio fuels (Godfrayet al., 2010).

The solution to food insecurity lies in the small scale farmers. For these farmers to increase food production two crucial approaches have to be utilized; the adoption of improved technologies and efficient utilization of available inputs and technologies.

Besides the development of new technologies, e.g. the use of fertilizers, new varieties and improved crop management practices, closing the gap between actual productivity and the potential productivity that could be obtained by using and adapting currently available technologies is crucial to facing this challenge (Godfrayet al., 2010).

Most farmers still use indigenous crop management practices like burning the soil and shifting cultivation to control pests and diseases and to improve soil fertility.

Finger millet (*Eleusinian coracan*) is a major food crop in the western part of Kenya and in most of African countries and has been an indispensable component of dryland farming systems. Finger millet serves as subsistence and food security crop due to its nutritive value (Holford, 1997). Finger millet is a crop that can easily be stored and is a rich source of methionine.

The crop is grown mainly for food, as beverage porridge and for brewing where it isused as malt. Finger millet is a highlynutritious cereal and in many respects issuperior to maize, wheat and rice. It also contains minerals such as calcium, iron and phosphorus. It hascalcium content of 344 mg per 100 g of ediblegrain compared to wheat with only 41 mg per100 g grain. It is also high in iron andtherefore very important as a weaning food forgrowing infants (Malleshi& Deskasher, 1986).

Finger millet is a self-pollinating cereal that thrives well in low rainfall areas. Finger millet is produced using extensive production system where limited capital input is utilized. The acreage production of finger millet has been decreasing.

Low yields in finger millet can be attributed to poor crop management practices that are done to the crop. It has also been recorded that low productivity of finger millet is due to the low level of technology used, poor policy impediments like seed trade policies, marketing hardships like poor market infrastructure and information barriers. Soil degradation and nutrient depletion due to continuous cultivation, removalor burning of crop residues, loss of nutrients through soil erosion, overgrazingbetween cropping seasons and inadequate use of inorganic fertilizers are themajor causes of declining food production per capita in smallholder farms in Kenya (Stoorvogel, Smaling, &Janssen, 1993).

Declining agricultural performance is a major driving force behind growing poverty among African farming populations, and its recovery offers the greatest prospects for rural populations to escape out of poverty. As mentioned earlier, food insecurity among the vulnerable poor rural farming populations induces a risk-minimizing conservative attitude towards farming and livelihoods systems. It is in this context that the potential role agriculture makes it significant to either be ignored or treated as just another small adjusting sector of the market economy.

The importance of traditional crops like finger millet cannot be over emphasized. This is because of their ability to thrive in soils that have low nutrients and they are resistant to most pests and diseases.

Traditionally, finger millet was grown on land that has been newly cleared. This land had enough nutrients and productivity was guaranteed. With the increase in human population, land has been very scarce and it is very difficult to come across virgin land since all agriculturally available land has been opened up for cultivation.

Since many tropical soils are inherently low in total phosphorus, shifting cultivation never really solved phosphorus problems in traditional agricultural systems; in some cases, phosphorus deficiencies were observed immediately after clearing. Finger millet production has for a long time been assumed to be a traditional crop. The use of modern technology like the use of fertilizer has not been seen as an option by the farmers. The traditional systems, therefore, relied on growing crop species with low phosphorus requirements and on efficient mycorrhiza associations to extract the small quantities of phosphorus in the soil. Due to diminishing soil fertility, production has reduced and most farmers have abandoned finger millet production.

This study attempted to establish how using the correct planting density and fertilizer can increase finger millet growth and performance. The objective of the study was todetermine the effect of phosphorus and plant density on finger millet (*Eleusinecoracana*) production.

METHODOLOGY

This research focuses on the elements of plant height measured in centimeters (cm), number of fertile tillers, finger millet seed weight in grams (g), finger millet percentage lodging and finger millet head length in centimeters (cm) as the dependent variables against the amount of triple supper phosphate (TSP) applied and the spacing used as the independent variables. In all the analysis in this section, an alpha level of 0.05 was used.

Location

The research focused in one geographical area which is Kuria West Sub county, Migori County. KuriaWestsubcounty is located in Migori County in the south western part of Kenya and covers an area of 581 km^2. It is located approximately latitude 1 degrees10 minutes south and longitude 34 degrees 27 minutes east. It has a population of 256, 086 persons according to the 2009 census. The main economic activity in Kuria west Sub County is farming and livestock production.

Climatology

Kuria is classified with the arid and semi-arid areas in Kenya. It receives an average of 1200 to 1500 millimeters in a year and has a dry period of three to four months per year. The area is elevated at an altitude of 1400 to 1800 meters above sea level. It has an annual temperature range of 20^0c to 30^0c. Kuria west sub county is classified as low midland 2 agro-ecological zones.

Soils

Soils samples in the experiment field was randomly sampled to the depth of 30 cm top soil and taken to Kenya Agricultural and Livestock Research Organization (KALRO); Food Crops Research Institute - Kisii Centre for a soil analysis. See appendix 1. Soils are a deep sandy loam with good water holding capacity and are classified as of marginal agricultural potential

Experimental Procedure

In order to reduce experimental error, this experiment was conducted for a period of two seasons, between the growing seasons of 2014 and 2015. The experiment was conducted in two seasons, the first season Seeding was done 21st November 2014 which is a short season and the second season planting was done on 23rd June 2015 this is a long rain season.

Land preparation

Finger millet is a small seeded crop that requires fine tilt. For the research to achieve a fine tilt, numerous land preparation practices were carried out. Land was cleared of bushes in order to make it workable. Land was cultivated by hand in the primary, secondary and tertiary preparations. The experimental site was ploughed, harrowed and finally hand leveled to ensure a fine tilth. This was done to maximize soil seed contact and improve uniform germinating.

Plot demarcation

Plots were divided into twelve plots of three by three meters and one-meter space all-round the plot. Each plot was treated by different levels of treatment and data on the performance was collected regularly. Each plot was labeled with a strong plastic strongly fastened on a stake and clearly marked with the respective treatments the plastic label was chosen due to its ability to withstand weathering.

Seeding

Kuria district has a two rain seasons that corresponds to the two planting seasons. Seeding was done 21st November 2014 which is a short season and the second season planting was done on 23rd June 2015 this is a long rain season. Furrows were made in each plot and different levels of Triple supper phosphate (0:46:0) fertilizer was used in planting to supply the crops with phosphorus. The furrows were then covered by slight soil then seeding was done. Seeds were dibbled by hand at a depth of 1.5 cm in furrows and each furrow was covered with a thin layer of soil. This was to ensure maximum germination. Triple superphosphate was applied as per the treatments 5 cm away from the seed line and was covered by soil. Two weeks after germination thinning was done to the required spacing as per the specific plot requirement. Top dressing was done after three weeks with Ammonium Sulphate 21:00:00. A flat rate of 50 kilograms of nitrogen per acre (0.045kg per plot) was added to all the plots. This was to ensure that Nitrogen was not a limiting factor and the variations that were to occur in the performance was due to finger millet plant density and phosphorus levels.

Weed control

The common practice of hand weeding was done with maximum care so as not to disturb the roots of finger millet seedling. Though time consuming, hand weeding ensured that there was a careful selection and removal of weeds like rapoko grass (*E. africana*) which is often difficult to distinguish from finger millet in the early growth stages. The crop cannot stand much weed competition in the early stages of growth so it is recommended to keep the crop field free from weeds all the time during the growing period.

During these experiments, weeding was done manually on the third week and the second weeding was done on the fifth week by uprooting the weeds from the plots and a small hoe was used to loosen the soil around the root.

Pest control

Furadan 5G was used to control soil borne pests, other pests like birds were controlled manually while aphids and flies were not witnessed in the experiment area during the growing period.

Harvesting

Harvesting was done 106 days on 27th February 2015 in the first season and 113 days on 15th October 2015 in the second season. This was done manually by cutting picking the heads that had turned brownish. A protected space which is reached by the sun, for sun drying was identified. The harvest was spread and dried. The heads were kept separately per plot and completely dried by airing pinnacles under the sun until the right moisture content was attained which is about 12%. Threshing was done and winnowing carefully done to clean the seeds from debris. The weight of finger millet grains was measured and recorded separately per plot.

Treatmentand Treatment Combination

In this experiment, 50 Kilogram Nitrogen per hector was top dressed to each plots. This was to limit the variation of nitrogen in the plot so that all variations in the variables measured could be attributed to phosphorus levels. The following was how treatment and treatment combination was done;

Treatment

In this study, Treatments constituted of a 3 x 3 factorial arrangement in a Completely Randomized Block Design. Each treatment was replicated three times. Treatments were spacing and fertilization. Spacing: according to the Kenya Agricultural Research Institute (KARI), the recommended spacing for finger millet is 30 cm inter rows and 15 cm intra rows. S1= 30 cm by 10 cm; S2= 30 cm by 15 cm (recommended) and S3=30 cm by 20 cm

P_2O_5 Levels: In order to supply Phosphorus fertilizer, Triple Super phosphate (0:46:0 N: P: K) was applied at four different rates as a treatment; F1= 0 kilogram per hector (control); F2=25 kilograms per hector; F3 = 50 kilograms per hector and F4= 75 kilograms per hector. According to Schulte and Kelling, 1992, the availability of phosphorus in Triple superphosphate has a solubility rate of 87%.

Treatment combination

Table 3.1 Shows Treatment Combinations of Spacing and Phosphorus Used in the Experiment in the Two Seasons.

	Fertilizer levels			
Spacing	**F1**	**F2**	**F3**	**F4**
S1	S1F1	S1F2	S1F3	S1F4
S2	S2F1	S2F2	S2F3	S2F4
S3	S3F1	S3F2	S3F3	S3F4

KEY

Spacing in cm	Phosphorus fertilizer in Kg/ha
S1 – 30X10	F1 – 0
S2 – 30X15	F2 – 25
S3 – 30X20	F3 – 50
	F4 – 75

Plot Layout

Experiments were laid out in a Randomized Complete Block Design with three replicates. This layout was used for two seasons but in different pieces of land.

Figure 3.1: Plots Layout in Three Replicates Used in the Two Seasons.

3.5DataCollection

Data regarding the following parameters was observed and recorded and were presumed to be the measure of finger millet performance; Plant height in centimeters was measured weekly, Number of fertile tillers was counted once after flowering, percentage lodging was measured once two weeks before harvesting, yield per plot once after weight once after threshing and the average head length of the finger millet estimated in centimeters per plot once after browning of the heads.

3.6 Data Analysis

Data collected was recorded and summarized in excel and analyzed using SPSS version 20. Research hypotheses were tested using two-way Analysis of Variance (ANOVA). A post hoc test was conducted by L.S.D. in order to compare the means of the finger millet performance parameters in the two seasons of the experiment.

RESULTS AND DISCUSSIONS

4.1Plant Height

Plant height was measured fortnightly for the two seasons. The data is presented in figure 4.1 below. It can be seen from the data that finger millet height increased with the increase in spacing and the amount of phosphorus levels applied. Blocks with 0 kg/ha produced the minimum plant height and those with 75kg/ha showed a higher plant height. It is evident that spacing also affected plant height since the lesser the spacing the higher the plant height was recorded.

When ANOVA was done (see Appendix II), it showed that there was a significant difference between seasons, P-levels and spacing ($p< 0.05$). It was also found that the interaction effect between spacing and P is significant. However, there was no significant difference between blocks ($p=0.308$).

A post-hoc analysis was done for both spacing and P-levels and the results are given in table 4.1 and table 4.2. The results showed a significant mean difference across all the treatments. From the table 4.1 below, it shows while all spacing had a significant mean finger millet height, the highest difference was between 30 x 10 and 30 x 20. While the least was 30 x 15 and 30 x 20.

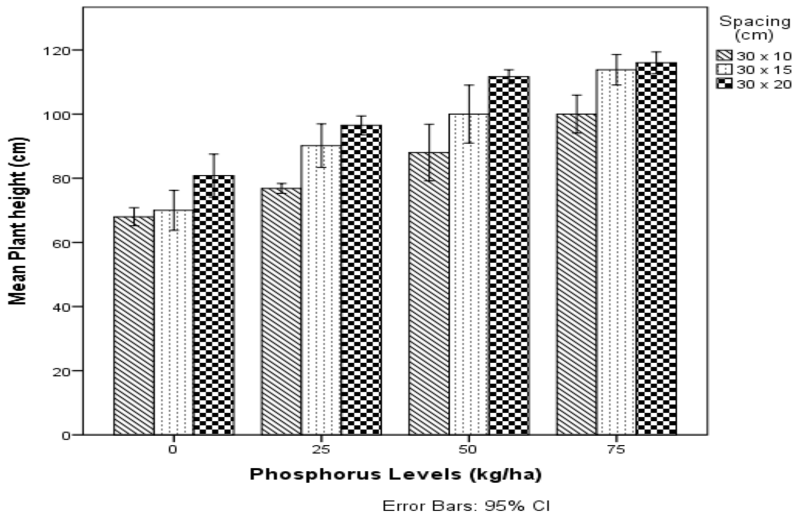

Figure 4.1: The effect of spacing and phosphorus levels on the Mean plant height.

An analysis of variance showed that there was a significant difference P-levels and spacing. This can be explained by the fact that, phosphorus helps in the root development in serials, more space meant that there was more room for roots and hence proper utilization of nutrients which in turn led to an increase in height of finger millet. This is supported by Epstein, 1972, who observed that Phosphorus helps in the formation of root nodules that increase the rate of Nitrogen fixation. Phosphorus helps in root formation and increases the growth rate of plants. It also helps in water use efficiency (Mokwunye et al., 1985).

Higher plant density finger millet leads to a competition for the growth factors and there reaches a point where even root development is hindered. This is supported by Barker, 1996, stated that spacing in finger millet influences the growth rate and productivity of the crop. Table 4.2 shows the marginal mean difference in plant height as a result of P – levels, the highest was between 0 kg/ha and 75 Kg/ha and the smallest difference was exhibited by 50 Kg/ha and 75 Kg/ha. This can be explained by the fact that Phosphorus helps in stem elongation and the soils initially had limited Phosphorus. Holford, 1997, noted that by adding phosphorus to soil low in available phosphorus promotes root growth and stem hardening in serials.

Table 4.1: Post-hoc analysis of the effect of spacing on plant height.

Spacing in cm	30 x 10	30 x 15	30 x 20
30 x 10		-10.29*	-18.04*
30 x 15			-7.75*
30 x 20			

*. The mean difference is significant at the 0.05 level.

Table 4.2: Post-hoc analysis of the effect of P-levels on plant height.

P -levels Kg/ha	0	25	50	75
0		-14.89*	-26.94*	-37.00*
25			-12.06*	-22.11*
50				-10.06*
75				

*. The mean difference is significant at the 0.05 level.

4.2 Percentage Lodging

Percentage lodging was measured once at the maturity of finger millet for all seasons. The data is presented in Figure 4.2 below. It can be seen from the data that finger millet percentage lodging declined with the increase in the amount of phosphorus applied. Smaller spacing recorded a lower percentage lodging than wider spacing.

From the ANOVA results (see Appendix III), it showed that there was a significant difference between seasons, P-levels had a significant effect in the lodging percentage of finger millet. But there was no significant difference of spacing to the percentage lodging of finger millet ($p= 0.803$). It was also found that the interaction effect between spacing and P-levels was not significant ($p=0.521$). However, there was no significant difference between blocks ($p=0.104$).

A post-hoc analysis was done for spacing and the results are given in table 4.2. The results showed a significant mean difference across the spacing. Phosphorous helps in strengthening of the stem of plants. An increase in phosphorus levels led to a general drop in the percentage lodging. Mokwunyeet al., 1985, observed that phosphorus is help in the filling of the seeds, in photosynthesis and the strengthening of stem. A well-developed rooting system in finger millet and a good stem may have had an impact in reducing percentage lodging (Watson, 2011).

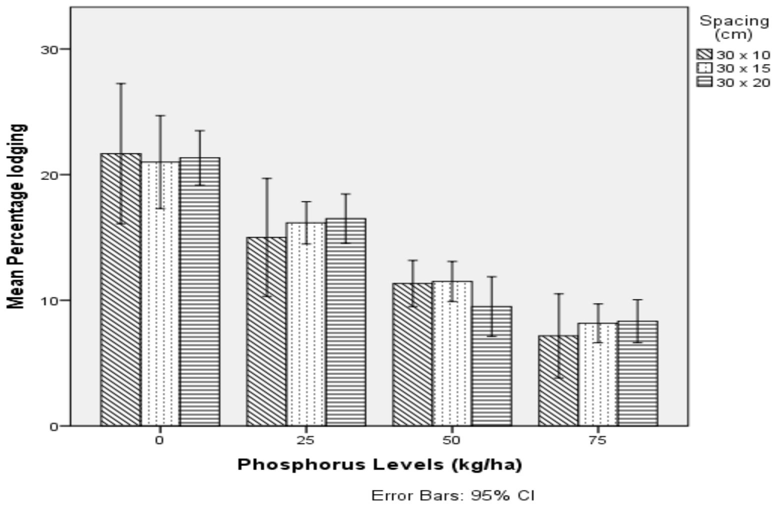

Figure 4.2: The effect of spacing and phosphorus levels on the Mean percentage lodging of finger millet.

Table 4.3: Post-hoc analysis of the effect of p levels on percentage lodging.

P-levels	**0**	**25**	**50**	**75**
0		5.44*	10.56*	13.44*
25			5.11*	8.00*
50				-2.89*
75				

*. The mean difference is significant at the 0.05 level.

4.3 Number of Fertile Tillers

The number of fertile tillers were counted per plot after they had flowered in all seasons. The data is presented in figure 4.3 below. It can be seen from the data that finger millet produced fertile tillers as the amount of phosphorus appliedtheincreased. Smaller spacing recorded a lower numbers of fertile tillers than wider spacing.

ANOVA results (see Appendix IV) showed that there was no significant difference between seasons (p=0.139),butboth P-levels and spacing had a significant difference. It was also found that the interaction effect between spacing and P-levels was not significant (p=0.931). Also there was no significant difference between blocks (p=0.663).

Post-hoc analysis was done for both spacing and P-levels and the results are given in table 4.4 and table 4.5. The results showed a significant mean difference across all the treatments. 30 x 20 had the highest difference which was significant.

The analysis of variance shows that there was a significant effect of P – levels on the production of fertile tillers. This can be attributed to the strong rooting network that Phosphorus has on cereals. With enough roots and nutrients, tillers had the opportunity to grow to maturity and become fertile i.e. produce heads. Wide spacing provided room for growth and less completion for minerals, sunlight and water. The post hoc results showed that overcrowding effect reduces the ability of finger millet to produce fertile tillers. P level of 75 kg/ha had the highest difference showing that tillering is a function of spacing and phosphorus level.Since wider spacing (lower plant density) reduces competition, it makes cereal crops to develop strong basal tillers which are fertile. Phosphorus helps in the rooting system of cereals.

Fertile tillers contribute to increased harvest of finger millet. De Datta (1981) reported that the number of tillers and panicles per square meter in a finger millet and other cereal population are largely a function of planting density or seed rate. Conducting his experiment in wheat, Bruce et. al., (1988) observed that Tillering increases dramatically with lower plant population levels, and these increases greatly increases crop yields.

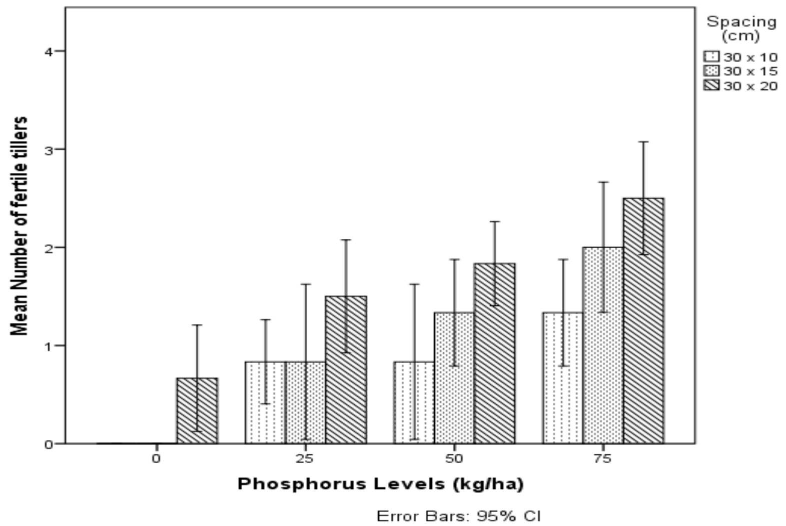

Figure 4.3: Effect of spacing and phosphorus levels on the Mean fertile tillers offinger millet.

Table 4.4: Post-hoc analysis of the effect of spacing on number of fertile tillers.

	30 x 10	30 x 15	30 x 20
30 x 10		-.50*	-1.00*
30 x 15			-.50*
30 x 20			

*. The mean difference is significant at the 0.05 level.

Table 4.5: Post-hoc analysis of the effect of P-levels on the number of fertile tillers.

	0	25	50	75
0		-0.56*	-1.00*	-1.61*
25			-0.44*	-1.06*
50				-0.61*
75				

*. The mean difference is significant at the 0.05 level.

4.4 Finger Millet Head Length

The average size of finger millet head was measured at the maturity point of finger millet per plot in centimeters. Data is summarized in the figure 4.4 below. The head length of finger millet increased with the increase in spacing (reduced plant population per unit area) and also it shows that as the level of fertilizer increases, the head length also increases.

From the ANOVA analysis (See Appendix V), results showed that there was no significant difference between seasons (p=0.069), but both P-levels and spacing had a significant effect. It was also found that the interaction effect between spacing and P-levels was significant (p=0.009). Also there was no significant difference between blocks (p=0.616).

The analysis of variance results indicated that there was a significance difference effect of p – levels on the head length this can be attributed to the fact that Phosphorus plays a role in seed fertilization and due to that more p level led to a higher head length. Shingguet al., 2009, Proper phosphorus dose plays an important role in increasing the yield of finger millet.

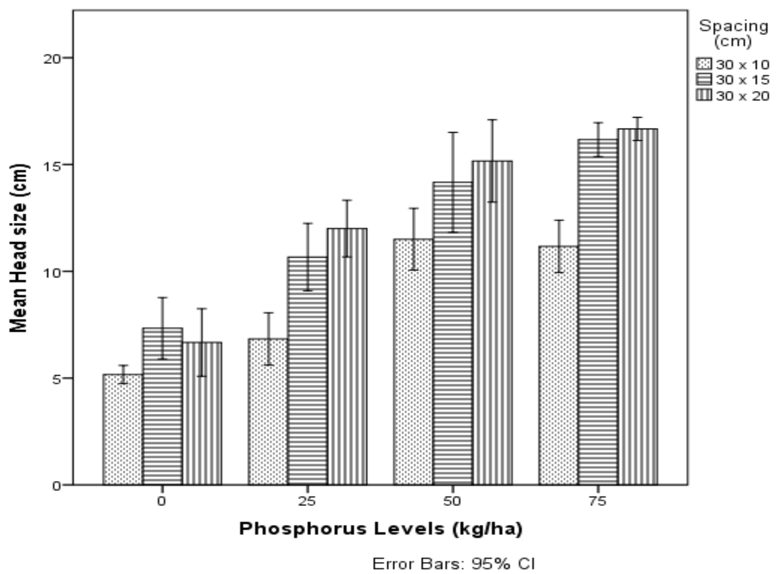

Figure 4.4: The effect of spacing and phosphorus levels on the Mean length of finger millet head.

Post-hoc analysis was done for both spacing and P-levels and the results are given in table 4.6 and table 4.7. The results showed a significant mean difference across all the all fertilizer levels. This shows that low plant density had an effect on the bigger size of finger millet length. From the P levels it is clear that 75 kg/ha had the highest effect and 50 kg/ha had a slightly lower effect.

Table 4.6: Post-hoc analysis of the effect of spacing on finger millet head length.

Spacing in cm	30 x 10	30 x 15	30 x 20
30 x 10		-3.42*	-3.96*
30 x 15			-0.54
30 x 20			

*. The mean difference is significant at the 0.05 level.

Table 4.7: Post-hoc analysis of the effect of P-levels on finger millet head length.

P levels	0	25	50	75
0		-3.44*	-7.22*	-8.28*
25			-3.78*	-4.83*
50				-1.06*
75				

*. The mean difference is significant at the 0.05 level.

4.5 GrainYieldper Plot

In this experiment, the total grain weight per plot was measured in grams after harvesting and threshing. The data is presented in figure 4.5 below. From the figure, it is clear that yield per plot increased with the increase in P-levels with P-levels of 75 kg/ha producing higher yields than lower levels of P especially at a wide spacing.A spacing of 30 x 15 produced higher yield per plot than the spacing of 30 x 20 at P – level 0, 25 and 50 kg/ha respectively.

A post-hoc analysis was conducted for both spacing and P-levels and the results are given in table 4.8 and table 4.9. The results showed a significant mean difference in spacing 30 x 10 and 30 x 15. Spacing 30 x 20 was not significant. In the case of fertilizer, the result showed a significant mean difference.

From the ANOVA analysis (See Appendix VI), results showed that there was a significant difference between P-levels and spacing It was also found that the interaction effect between spacing and P-levels was significant ($p < 0.05$).

An analysis of variance results indicated a statistically significant effect of phosphorus levels to the yields per plot. This is due to the fact the phosphorus is the main player in the photosynthesis and the manufacture of starch which is stored in the grains. The ATP is then available as an energy source for the many other reactions that occur within the plant, and the sugars are used as building blocks to produce other cell structural and storage components(Novais& Smyth, 1999). The interaction between P – levels and spacing was significant to show that the contribution of plant density to the ultimate goal of yields cannot be underestimated. This is because for maximum output, Shingguet al., 2009, observed that the right spacing can lead to a higher yield and could be adopted as an alternative for the control avoid the stress in finger millet.

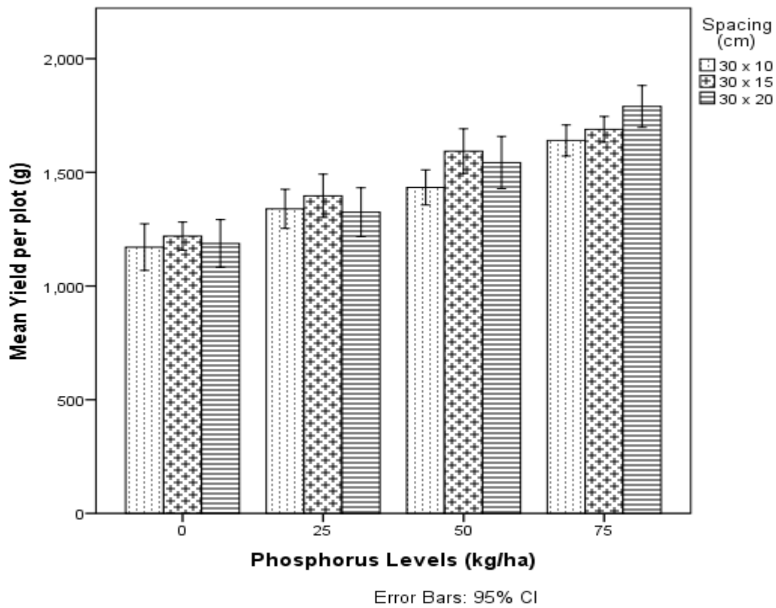

Figure 4.5: The effect of spacing and phosphorus levels on the yield per plot of finger millet.

The highest mean difference was between spacing 30 x 10 and 30 x 15 which was significant. The lowest difference was between spacing 30 x 15 and 30 x 20 which was not significant. This is because as much as the right plant population increases harvest, beyond the optimum, the rule of diminishing marginal returns sets in. Mukherjee andKuntal (2012), noted that plant density has to be optimal in order to compete with weeds and absorb nutrient and moisture for good growth and development. When plant density is too high, it encourages inter plants competition for resources. P – level 75kg/ha had the highest mean difference and was significant. This further explains the importance of phosphorus in grain formation.

Table 4.8: Post-hoc analysis of the effect of spacing on finger millet yield per plot.

Spacing in cm	30 x 10	30 x 15	30 x 20
30 x 10		-78.33*	-65.08*
30 x 15			13.25
30 x 20			

*. The mean difference is significant at the 0.05 level

Table 4.9: Post-hoc analysis of the effect of P-levels on yield per plot of finger millet.

P level	0	25	50	75
0		-160.94*	-330.61*	-513.89*
25			-169.67*	-352.94*
50				-183.28*
75				

*. The mean difference is significant at the 0.05 level.

CONCLUSIONS AND RECOMENDATIONS

5.1 Conclusions

In this experiment, the first objective was to determine the effect plant density on finger millet (*Eleusinecoracana*) productivity, plant density was measured by different spacing. Productivity was measured by estimating plant height, percentage lodging, number of fertile tillers, finger millet head length and yield per plot. From the results, plant density plays a fundamental role in finger millet performance. Results showed that the effect of spacing was significant in plant height, Number of fertile tillers, finger millet head length and finger millet yield per plot. Although there was no significant difference in finger millet lodging percent.

The second objective was to establish the effect of different levels of Phosphorus fertilizer on finger millet (*Eleusinecoracana*) productivity. The results showed that there was increase in performance in most of the parameters being evaluated as the P levels increased. The P levels had a significant effect on plant height, percentage lodging, number of fertile tillers, finger millet head length and yield per lot.

The third objective was to determine the effect of the interaction between spacing and phosphorus levels on plant height, percentage lodging, number of fertile tillers, finger millet head length and yield per lot. The interaction effect was significant on plant height, finger millet head length and yield per lot. Meanwhile the interaction effect was not significant in percentage lodging and number of fertile tillers.From the results, it was found that there was a significant increase in productivity in finger millet as phosphorus levels increased from 0 to 75 kg/ha.

5.2 Recommendations

From this experiment results indicated that 75 kg/ha can be used and increase yield of finger millet. The results are consistent with other research carried out elsewhere in the world of phosphorus and plant population.

The finger millet spacing of 30 x 15 recommended by KARI produced significant results.

The interaction between plant population (spacing) and phosphorus levels indicated a significant improvement in yields and other parameters measured like height from this experiment 75kg/ha of phosphorus and a spacing of 30X15 cm is recommended in this area.

Further research needs to be done to evaluate the economic level of phosphorus use and the effect of phosphorus on finger millet in different cropping systems.

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