Women Education for Social, Economic and Political Development in Kenya

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Abstract

Various national regional and international conventions and documentation have emphasized that enabling the population regardless of gender to actively participate in social and economic well being is critical for long term and sustainable social, politica l and economic development of any society. One way of empowering the population is through education. Education is the process by which people acquire knowledge, skills, values and attitudes by which they develop an appreciation of their cultural values, through which all these are passed from one generation to the other. Education is the true bedrock of the society"s culture, civilization and a powerful tool for perpetuating social, political and economic development. As such, education is pivotal to overa ll development of humankind. According to the human capital theory, "The greater the investment in education, the greater the collective benefits to the society and the greater the benefit the participants are likely to get." Further, the collective benefi ts for the society increase with higher participation of women in education. For over a decade now, educating girls/women has been identified to have both direct and indirect benefits. Improved maternal health, lower incidences of HIV/AIDS, poverty reduction and environmental protection are but some of the positive outcomes when girls/women are educated. The impact of educating women actually goes beyond them and their family to enrich the entire nation. It is in the light of this that this paper seeks to d iscuss the diverse social, political and economic benefits that accrue from educating women. Based on the discussions, recommendations will be made that will go a long way to enhance women education in general and particularly in Kenya.

Keywords: *Social, Economic, Political, Education, Development*

Introduction

Various national, regional and international conventions and documentation have emphasized that enabling the population regardless of gender to actively participate in social and economic well being is critical for long term and sustainable social, economic and political development of any society (Cochrain, 1979). One way of empowering the population is through education. Education is the process by which people acquire knowledge, skills, values and attitudes by which they develop an appreciation of their cultural values, by which they make necessary rules, laws and obligations that, ensure the survival of the society and by which all these are passed from one generation to the other. Education therefore is the true bedrock of the society‘s culture, civilization and a powerful tool for perpetuating social, economic and political development. As such, education is pivotal to overall development of human kind (Christiana, 2002).

According to the human capital theory, ―The greater the investment in education, the greater the collective benefits to society and the greater the benefits the participants are likely to get.‖ Further, the collective benefits for the society increase with increased participation of women in education (Coleman, 2004). In this perspective, education is a cornerstone of economic growth and social development and a principle means of improving the welfare of individuals (Mason & Andrew, 2001).

Scholars contend that there is no question that educating citizenry pays off in benefits to the nation as a whole. One Orodho (2002) especially concurs with the above statement but counsels that, although direct evidence of the causal relationship between formal education and development in developing countries is rather blamed as less extensive than for the more industrialized countries, enough signals are in place which indicate that appropriate education and training, especially for girls/women would have a more positive impact on the socio -economic and political development of developing countries like Kenya(Kane, 2004).

Additionally, education may be viewed as the key to women‘s future as it enables them to widen their horizon beyond child bearing and household drudgery. Women constitute more than 50% of the population in Africa and more than 51% of the total population in Kenya(Summers & Lawrence, 1994). With the knowledge and skills acquired through education, women are able to efficiently and effectively undertake their roles in the society. The impact of educating girls/women actually goes beyond themselves and their family to enrich an entire nation. This paper therefore seeks to discuss the diverse social, economic and political benefits that accrue from educating women. In view of this, recommendations will be made that will go a long way to enhance women education in general and particularly in Kenya.

Social Benefits

The social benefits that accrue from education are quite evident and when more educational opportunities are opened to girls/women, such benefits are even greater (Kane, 2004). Available evidence suggest that, if a mother is more educated she may play a greater role in family decision making, makes her aware of proper medical care which reduces infant and child mortality, makes her break away from traditions which promote gender discrimination in the society and may greatly enable her access higher status occupations which lead to improved income and social status (Dollar & Gatti, 1999).

In this context therefore, education en hances the woman‘s decision making autonomy at home, their exposure to the outside world, their conjugal family orientations and their control over the family resources. Studies have shown that there is a strong positive correlation between parental educat ion particularly the level of a mother‘s education and a child‘s health. Educated women are able to provide better nutrition and general health care for their children compared to the illiterate mothers. In fact, educated women are much likelier to have significantly less malnutrition in the family (Dollar, 1999).

Strong positive relationship has also been observed between women‘s education and fertility rate. In terms of arresting population growth, the fastest and the most effective and cheapest method is the schooling of girls. This is because education affects the demand for children for example, by changing the perceived costs and benefits of having children and the ability to afford children and by altering preferences as reflected in the ideal family size. Additionally, education affects the supply of children by affecting the age of marriage and the relationship between husband and wife by increasing knowledge of contraceptives and possibly, though not always, by changing attitudes towards contraception.

Women with higher levels of education normally delay their first birth thus; maturity at the time of their first birth might lead to improved child care hence reducing the mortality rate of children born to the educated women. Further, child mortality is reduced by as much as 10% for children less than five years with each additional year of schooling for their mothers after primary education. Educated women are able to secure earlier and longer schooling for their children and are also knowledgeable ab out school opportunities for them. They are even more involved with the psychological development of their children than the uneducated mothers (Mason & Andrew, 2001).

One of the reasons so many experts and economists believe educating girls is one of the most important investments in the world is how much they give back to their families. Most of the social benefits that accompany increased education are attributable to girls who use their schooling more productively than boys. Women in the developing world who have had some education share their earnings with the family members while majority of men keep a third to a half of their earnings to themselves (Kane, 2004).

To be born a girl in a rural area in some African communities means being doomed to a life without education and clean water, with early marriage and babies coming too early, too many births, babies who die of preventable diseases, backbreaking work in the fields, emotional subordination to her husband and family and an early death. Social exploitation of girls and women is another route open for male domination of the female deprived of education. The uneducated woman therefore transmits to her children the same doomed life. However, educating women enables them to overcome such traditional obstacles and to obtain increased control over their lives and that of their children.

Women with some education are less likely to subject their daughters to the practice of female genital mutilation and early marriages. This is mainly due to the fact that they are aware of the negative consequences of such practices compared to the uneducated women. Studies have also demonstrated that an increase in the education of women is significantly related to the decreases in HIV/AIDS infection rate. In fact, education is often referred to as the social vaccine for HIV/AIDS. This is attributed to the fact that educated women have a lot of information on the scourge and how it can be transmitted compared to the uneducated women. Finally, education gives girls and women access to employment opportunities as well as enabling them to act as role models in the society. From the foregoing discussion, it‘s evident that girls/women education is an important social tenet to national development and therefore should be supported by all.

Economic Benefits

The Universal Primary Education (U.P.E) and the Gender Equality and the Empowerment of Women are both central to the 2000 United Nations Millennium Development Goals (M.D.G's) (Mason & Andrew, 2001). This demonstrates the international communities' recognition that investing in women education could be one investment with the highest returns in the developing world. The substantial gains that increased schooling for females have on economic outcomes have indeed made economists t o conclude that investment in women education may well be the highest return investment available in the developing countries including Kenya (Dollar, 1999). The World Bank therefore advises that since investing in primary education yields higher returns than investing in higher levels in low income nations, and because girls are more concentrated at lower educational levels, closing the gender gap in primary education is the most beneficial economic strategy for developing countries (Karani, 2004).

Women usually manage food, water, fuel, intensive agriculture and birth spacing. It therefore implies that a woman with at least six years of education will be a critical actor in farm productivity, livelihood diversity, resource conservation and population control. Women economic contribution on a global basis ranges from 10%-58% of full household income, cash income, income in kind and the value of labour devoted to unpaid activities carried out by its members. In fact, women engage in more total productive time than men. Although the amount of time spent in paid activities is less for women than for men, they spend a larger amount of time in some production relative to men. For instance, in Africa, 70% of the food is grown by women, in Asia; the figure is 50% -60% while in Latin America it is 30%. In Kenya, 60% of the rural households are headed by women who do most of the farm work. With many women being the main farmers, education offers them a chance to develop more efficient farming practices improve output and raise awareness of the ecological needs of the land. Studies have indicated that educating girls in areas with little schooling substantially increases agricultural productivity and that one extra year of primary education increases farm yields more than increased access to land or fertilizer usage (Sperling, 2005).

Another economic benefit of educating girls is that when girls are provided with one year of education beyond the average (primary education), it increases eventual wages by 10% -20%. This improves their economic status in the society. Further, increasing the portion of females with a secondary education by 1% increases a nation's annual per capital income growth by 0.3 percent (Eshiwani, 1993). Generally, from a technical perspective, education leads to the acquisition of technical skills and positive attitude that are likely to increase economic productivity of an individual. In this regard, education helps to reduce poverty by increasing the value and efficiency of the labour force. In fact, as economics world wide are transformed by the technological advances, particularly with the advent of information technology (IT) and the emergence of globalization and new production methods that depend on the well-trained and intellectually flexible labour force, education becomes even more significant. It is therefore apparent that equipping girls/women with the technical skills is likely to increase their economic productivity.

The economic development of a country is greatly dependent on the safety of its environment. Women have a vital role to play in ensuring environmental safety, management and development and therefore, their full participation in ensuring this is essential to achieve sustainable economic development (Mason & Andrew, 2001). As managers of the environment, women are key agents in the balance between population and environment, as they greatly contribute to the control of population growth. Through their knowledge on family planning methods, women can make a contribution to a reductio n in the rate of population growth and as population pressure is a key factor in environmental degradation, it is to be assumed that a reduction in population would benefit the environment. Fewer births especially among educated women will benefit them because this enables them to be more efficient in their roles of environmental management. Educated women are also more efficient in educating their children on environmental issues than the uneducated. World Bank asserts that if developing countries like Ken ya improve their economies but maintain current rates of population growth, the consequences of increased environmental degradation will be enormous. In fact, World Bank concludes that improved participation of women in education leads to one of the highes t returns in environmental protection (Summers & Lawrence, 1994).

In conclusion, the World Bank knows it and every development economist knows that Education of girls is the surest way in the world of reducing poverty. For over a decade now, education for girls has been identified as one of the best solutions to reversing the relentless trade of poverty and diseases devastating large portions of sub-Saharan Africa. Access to education for girls therefore directly improves the feasibility of not only the second and the third U.N. Millennium Development Goals (U.P.E and Gender Equality and Empowerment of Women respectively), but also it will go a long way to ensuring the achievement of the first, fifth and the sixth Millennium Development Goals that is reduct ion of rural poverty, improved maternal health and lower incidences of HIV/AIDS, respectively (Eshiwani, 1993).

Political Benefits

On the political arena, education is perceived to have a positive impact on making informed decision and choices, and contributes to the formulation of sound political policies by strengthening good governance and the evaluation of a civil society through community and national capacity building. Women education facilitates their participation in governance. Governance implies the process of decision making and the process by which decisions once implemented at the different levels at which public affairs and resources are managed. Such decisions have impacts on the ability of people especially women to access control, utilize and enjoy the resources. The concept of governance therefore implies the power to make decisions that affect the capacity of individuals and groups to develop and achieve their full potential in social, economic and political life (Dollar, 1999).

Men and women are an equal resource of a community and a nation. Educating women is the key strategy used to build and enhance women‘s capacities, capabilities and increase their choices so that they can actively and equally participate in decision making processes for enabling their own well- being, as well as that of their families and the community. It also increases their opportunity to participate in decision making or endorse decisions affecting their lives. This is because empowerment builds and reinforces positive self confidence and self esteem. Through this process, women develop analytical skills to take appropriate and timely decisions which are a crucial requirement for active participation in governance. Additionally, education and awareness through info rmation is an indispensable input in the process of empowerment to facilitate women‘s decision making capacities and capabilities to participate in governance and develop need based policies and implementing relevant programs (Sperling, 2005).

Traditionally, women are usually viewed as home makers and their managerial and co - ordination roles are seldom recognized. Educating girls is therefore important in that it enables them to challenge existing unequal power relations and in the process they gain greater self confidence and enhance their own personal skills and capabilities to dialogue and negotiate for others while gaining greater control over the external factors that influence their participation in governance.

Educating women therefore enables them to contribute to emergency of policies and programmes that put their needs and concerns into consideration. If women are involved at decision making levels in political and administration issues, focus on women‘s concerns for example gender violence, early marriages and Female Genital Mutilation (FGM) among other issues would be alleviated to a great extent. Women concerns which are usually taken casually, ignored or marginalized would move centre stage to demanding attention in policies and solutions. They would also succeed in transforming them into social issues rather than being dismissed as peripheral issues which concern women only. Indeed, women participation in governance is not a luxury or fashion, it is absolutely necessary for the development of women, community organization and the nation at large. There is therefore an urgent need for women to have greater access to education and this will increase their access to decision making structures and to acquire the skills needed to participate in the formulation of policy and legislation.

Recommendations

From the foregoing discussion, the social, economic and political benefits that result from educating girls/women are evident. It is in the light of this that the following recommendations are made:

Awareness campaigns on the importance of education and more so that of girls should be intensified. This will help to change the prevailing negative attitude towards girls‘ education by parents and the society at large. Parents will therefore be motivated to invest in the education of their children indiscriminately.

Since girls/women education was identified as one of the key social-economic factors that influence fertility rate by changing attitudes towards contraception, influencing demand for children by changing the perceived costs and benefits of having children and the ability to afford children and by altering preferences as reflected in the ideal family size, the Kenyan society should be given adequate information on how education can be used as an imp ortant tool to arrest rapid population growth. Awareness campaigns also should be intensified in order to sensitize the Kenyan society regarding the negative effects of some of the retrogressive socio -cultural practices on girls/women education.

Guidance and counseling in schools by teachers and role models should be intensified in order to change the prevailing negative attitude towards education that is still held by some girls. This will increase girls‘ participation in education hence improve their con tribution in the social, economic and political development of the country.

Secondary schools education should be highly subsidized through bursary scheme and school fee waivers especially for girls from poor and vulnerable families. It should also be aut omatic that the bright girl‘s from poor families should be provided free secondary school education; this will increase their participation in education and improve their contribution to national development.

To promote girls education for increased nation al development, the Government of Kenya should put up more boarding schools for girls‘ especially in arid and semi arid lands (ASALs) and low agricultural potential areas and equip them adequately with appropriate learning facilities. This move will encourage more girls from poor families in these areas to enroll in boarding schools instead of having to traverse bandit-infested distances through the bush to school.

Awareness raising activities to increase the participation of women in education and subsequently at decision making levels within the family, community, political and government spheres should be encouraged.

Conclusion

Among the socio-economic forces that will determine the future progress of developing countries especially in sub-Saharan Africa, education, particularly that of girls/women is at centre stage. Women play an important role in the development of the smallest social institution, the family as well as at national and global levels. Governments should therefore focus their efforts on improving girls‘ access to education thereby increasing their enrolment rate and educational benefits.

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Phosphorus Efficiency among Selected Sorghum (*Sorghum Bicolor L. Moench*) Lines and Segregating Families

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Abstract

Sorghum (Sorghum bicolor (L.) Moench) is an important food security crop in Kenya but its production is limited by low available soil phosphorus (P) amongst other factors. This is because its cultivation is mainly carried out by resource limited peasant farmers in marginal agricultural areas that are characterized by soils with very low P levels. This study was carried out to evaluate Kenyan sorghums that are tolerant to low P levels. A P efficient sorghum line, MCSR L6 was crossed with a P ineffi cient but P responsive line, MCSR N64. The resultant F_1 seed was selfed to produce F_2 seed that was used in the current study. Six F_2 segregating families were characterized for P efficiency in the field with low available P (3 mg of P/kg of soil). MCSR L6 yielded better than MCSR N64, under low available P, but showed poor response to P application in the field. The F_2 sorghum families segregated in terms of days to 50 % flowering, plant height, leaf number per plant, tiller number and grain yield. Based on grain yield, the six sorghum families were classified into four groups; efficient and responsive to P, inefficient and responsive to P, efficient and non -responsive to P, and inefficient and non -responsive to P. The results indicate that the F_2 progeny show genetic variability for P efficiency and responsiveness to additional P, implying that these two traits were successfully transferred from the parents to the progenies.

Keywords: *Sorghum Bicolour*, *Phosphorus Efficiency, Segregating Families*

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is the second most important cereal crop after maize in sub-Saharan Africa (Zidenga, 2004). In Kenya, sorghum is an important food security crop which is grown principally in the often drought-prone, marginal agricultural areas of Eastern, Nyanza and Coastal provinces (EPZA, 2005).

The soils where sorghum is cultivated, especially in Western Kenya, have very low available phosphorus (P) (Okalebo *et al.*, 2004). Available P levels in these soils range from 2 -5 mg/kg soil; which is far below the 10-15 mg/kg required for optimal crop production. Therefore low P availability in the soil is among the primary factors limiting sorghum production in most regions of Kenya.

Application of inorganic phosphate fertilizers is the traditional way of increasing crop production in soils with low P (Zhul *et al.*, 2001). Phosphorus is a macronutrient whose availability has profound consequences for plant growth and physiology (Abel *et al.*, 2002) and is required by plants in large doses. The use of large doses of P fertilizers is normally too expensive for the small scale -farmers who dominate the sorghum cultivation. Moreover, utilization of P fertilizers by crops is often very low, ranging from 10 to 30 % in the year applied, due to the high P fixing capacity of acid soils (Zhul *et al.*, 2001). There is need to reduce sorghum production costs by deployment and adoption of low input technology. One of the approaches is the deployment and adoption of P-efficient sorghum varieties.

Genetic potential for P efficiency has been reported in several crops including wheat (Zhul *et al.*, 2001), rice (Ahmad *et al.*, 2000), cowpeas (Krasilnikoff *et al.*, 2003), maize (Corrales *et al.*, 2007) and sorghum (Schaffert *et al.*, 2001). The Moi University Sorghum Research Team screened a large collection of local Kenyan accessions for P efficiency and identified highly P efficient accessions . The accessions were selfed and further tested to develop stable inbred lines, and MCSR L6, which is P efficient, was among the lines that were developed. MCSR L6 was then crossed with a P inefficient but locally adapted farmer preferred line, MCSR N64. In this study F_2 sorghum families from the cross were screened for P efficiency at Sega in Siaya district where soil P level is about 3 mg/kg of soil.

The objective of the study was to evaluate the F_2 segregating sorghum families in the field under low P to determine whether P efficiency was successfully transferred from parent MCSR L6 to the progenies.

Materials and Methods

The field experiment was carried out at Sega in Siaya district of Nyanza province, which is located 34˚ 15‘ E, 0˚ 15‘ N, at an altitude of 1300 meters. It has a mean annual rainfall of 800 to 1200 mm and the mean temperature is about 24˚C (National Geographic Society, 1996-2010). The soil is acidic (pH 5.1); with low available soil P of 3 mg/kg of soil.

Sorghum Seed

The sorghum seed from inbred lines, MCSR N64 and MCSR L6 that contrast in tolerance to low available P in the soil and F_2 seed were used. The sorghum lines were developed from local Kenyan accessions through 6 cycles of selfing and selection, and were provided for the study by the Moi University Sorghum Research Team. MCSR N64, which is P inefficient, received pollen from the P efficient line MCSR L6. The F_1 seeds were sowed and plants selfed during the 2007 short rains season to obtain F_2 seed. The F_2 seed was grouped into six families; seed from each F_1 plant formed a family. The F_2 seeds were planted out and selfed in the field to obtain $F_{2:3}$ seed. The $F_{2:3}$ seed from each family was further grouped as either P efficient or inefficient based on grain yield of individual plants planted under low P.

Field Evaluation

The experiment was carried out under a P-deficient soil (3 mg/kg) and was laid out in a split plot design with four replications; phosphorus levels comprised the main plots and sorghum accessions being the sub-plots. The phosphorus levels were low P (no P application) and adequate P (90 kg P_2O_5 ha^{-1}). The F_2 seed and the parentals were sowed in sub-plots of 2 m rows with a spacing of 60 cm between rows and 20 cm within rows and seedlings were thinned to a single plant per hill when they reached six-leaf stage. All the sub-plots were supplied with nitrogen in form of calcium ammonium n itrate fertilizer at planting and as side dressing 6 weeks after planting to a total of 39 kg of N /ha. Recommended insecticides and fungicides were used to control pests and diseases.

Scoring of phenotypic characters was done on the middle rows with outer rows being considered guard rows. Ten plants per row in the middle rows were randomly selected for evaluation and tagged just before flowering. A total of 40 plants per sorghum family under each P level were evaluated. The morphological characters evaluated included days to 50 % flowering; leaf number, tiller number, panicle length, panicle width and total plant height at maturity; and seed weight after threshing.

Classification of the F_2 sorghum families in terms of P efficiency and responsiveness to P was done. Sorghum families with grain yields above the trial mean under low P level were classified as P efficient and those with relative response to P above mean relative response were classified as P responsive (Schaffert et al., 2001). The sorghum families were classified into four groups; efficient and responsive to P (ER), inefficient and responsive to P (IR), efficient and non -responsive to P (EN), and inefficient and non-responsive to P (IN).

Data Analysis

The data was subjected to analysis of variance (ANOVA) and mean separation was done using Duncan‘s multiple range test using SPSS® software (SPSS Inc. Chicago, USA). A probability equal to or less than 0.05 ($P \leq 0.05$) was considered to be statistically significant.

Results

The F_2 segregating sorghum families and the parents showed significant variations the morphological traits in the field (Table 1). There were significant differences ($P < 0.05$) among the sorghum accessions and between P treatments in days to 50 % flowering, but the interaction of P level x genotype was non-significant. Both parents MCSR N64 and MCSR L6 showed no sign ificant differences in 50 % flowering under low P. However, under adequate P, MCSR N64 flowered earlier than parent MSCR L6. Most of the F_2 sorghum families flowered later than either parent both under low P and adequate P. Among the F_2 sorghum families, family 6 flowered early (86 d and 82 d) under both low P and adequate P respectively. Within each sorghum family and parental line, plants grown under low available soil P tended to flowered later than those supplied with adequate P.

There were significant differences ($P < 0.05$) among the F_2 sorghum families and the parents, and between P treatments in total plant height. Parent MCSR N64 was shorter than parent MCSR L6 under both low P and adequate P. In comparison with the parents, the F_2 sorghum families were taller both under low P and adequate P. However, families 4 and 5 were shorter than parent MCSR L6 under adequate P. Within each sorghum family and parental line, plants grown under low available soil P were shorter than those supplied with adequate P.

Table 1. Effect of P Treatment on 4 Quantitative Traits of F_2 Sorghum Families and the Parents

	Daysto50% flowering		*Plant height, cm*		*Leaf No.*		*Tiller No.*	
	Low P	Adequate P	low P	adequate P	Low P	adequate P	low P	adequate P
MCSRN64	85^{ab*}	77^{c}	124.2^{d}	128.0^{cd}	8^{d}	8^{d}	0^{c}	1^{b}
MCSR L6	83^{ab}	82^{b}	157.3^{b-d}	179.0^{a-c}	8^{d}	9^{c}	0^{c}	1^{b}
Family1	87^{a}	85^{ab}	202.4^{ab}	193.0^{ab}	10^{bc}	11^{b}	0^{c}	2^{a}
Family2	87^{a}	86^{ab}	172.2^{a-d}	198.5^{ab}	10^{bc}	11^{b}	0^{c}	1^{b}
Family3	87^{a}	82^{b}	182.1^{a-c}	217.0^{a}	10^{bc}	12^{a}	0^{c}	2^{a}
Family4	87^{a}	86^{ab}	200.1^{ab}	176.4^{a-d}	10^{bc}	12^{a}	0^{c}	1^{b}
Family5	88^{a}	86^{ab}	183.6^{ab}	175.6^{a-d}	10^{bc}	11^{b}	0^{c}	1^{b}
Family6	86^{ab}	82^{b}	179.2^{a-c}	200.3^{ab}	10^{bc}	12^{a}	0^{c}	2^{a}

*Means of each trait followed by the same later are not significantly different at $p \leq 0.05$.

The number of leaves per plant differed significantly ($P < 0.05$) among the F_2 sorghum families and their parents, and between P treatments. The F_2 sorghum families had more leaves per plant compared to the parents under both low P and adequate P. Sorghum plants within each family and parental line that were supplied with P had slightly more leaves than those plants under low P. Tillering differed significantly ($P < 0.05$) among the F_2 sorghum families, and was also influenced by P treatment. With adequate P application families 1, 3 and 6 produced more tillers. Also, sorghums grown under adequate P tillered more than those grown under low P.

Table 2: Effect of P Treatment on Grain Yield of F_2 Sorghum Families and the Parents

Accession	***Seed weight/plant, g***		***% P response (B/A*100)***	***Class*****
	Low P (A)	**Adequate P (B)**		
MCSR L6	25.65^{d-i}	28.00^{c-i}	109	E N
MCSR N64	20.26^{i}	33.18^{b-i}	164	I R
Family-1	21.88^{ei}	38.53^{a-d}	176	I R
Family-2	30.13^{c-i}	51.70^{a}	171	E R
Family-3	24.81^{d-i}	36.82^{b-e}	128	I N
Family-4	28.38^{ci}	46.82^{a-c}	165	E R
Family-5	25.46^{d-i}	25.90^{d-i}	102	E N
Family-6	25.02^{d-f}	50.03^{a-b}	200	I R
Trial mean	25.39	38.11	152	

* Means followed by the same later are not significantly different at $p \leq 0.05$.

** I- P inefficient, E- P efficient, R- P responsive, N- P non-responsive.

The grain yields differed significantly ($P < 0.05$) among the F_2 sorghum families and the parents, and between the P treatments (Table 2). MCSR L6 yielded better than MCSR N64 under low P but in contrast, MCSR N64 yielded better than MCSR L6 under adequate P supply. The F_2 sorghum families showed segregation in grain yield under both low P and adequate P supply. Most F2 sorghum families yielded better than the P inefficient parent MCSR N64 under low P, with families 2 and 4 yielding even better than the P efficient parent MCSR L6.

When supplied with adequate P, the F_2 sorghum families yielded better than either parent, except for family 5. The yield for all the entries was better when P was applied. MCSR N64 responded better to

P application than MCSR L6. Among the F_2 sorghum families, family 6 showed the highest (200 %) relative response to P supply while family 5 (102 %) showed the lowest relative response to P supply.

The F_2 segregating sorghum families and parents were also grouped in terms of P efficiency under low P and responsiveness to P supply based on their grain yield in the field (Table 2). MCSR L6 and family 5 were grouped as P efficient but non -responsive to P application. Parent MCSR N64 and families 1 and 6 were grouped as P inefficient and responsive to P supply. Families 2 and 4 were P efficient and responsive to P supply, indicating that these families inherited both the P efficiency of MCSR L6 and P responsiveness of MCSR N64. In contrast, Family 3 was grouped as P inefficient and non-responsive to P supply.

Discussion

Parental sorghum lines, MCSR L6 and MCSR N64, and the F_2 sorghum families showed significant morphological differences when grown in the field with or without P application. The F_2 sorghum families showed segregation in days to 50 % flowering, total plant height, leaf number and tillering when compared with the parents. Most of the F_2 sorghum families flowered later, were taller, had more leaves and tillered more than the parental lines. The high yields of the F_2 sorghum families than the parents can be attributed to heterosis; a phenomenon where when inbred lines are crossed, the progeny show an increase in character means for traits that previously suffered a reduction due to inbreeding depression (Falconer, 1989). Regardless of the sorghum family or parental line, sorghum plants grown under low P tended to flower later, were shorter, had fewer leaves and tillered less compared with plants supplied with P fertilizer. According to Camacho *et al.* (2002), morphological variables have been used to express the influence of mineral nutrients on plant growth patterns since vegetative growth responds positively to fertilizer application. Plant height, leaf number (Camacho *et al.*, 2002), tillering and grain yield (Castillon, 2001) are reduced by low available P. However, plant maturation is delayed by low P availability.

The P efficient parent, MCSR L6 had a higher grain yield than the P inefficient p arent, MCSR N64 under low P. In contrast, MCSR N64 had a higher grain yield than MCSR L6 with adequate P application. This implies that although MCSR L6 is P efficient, it responds poorly to additional P compared to MCSR N64. Schaffert *et al.* (2001) attributed the poor response of some sorghum genotypes to P application to yield ceiling effect. MCSR N64 seems to be a useful sorghum line in breeding because although it is P inefficient, it responds well to additional P application and can transmit this to th e progenies.

Some of the F_2 sorghum families performed even better than the P efficient parent under low P, and better than the P responsive parent when supplied with P. The higher performance in some of the F_2 sorghum families compared to the parents can also be attributed to heterosis of the sorghum families.

The F_2 sorghum families were grouped in terms of P efficiency and response to P supply. Some of the families segregated towards parents MCSR L6 and MCSR N64 by being P efficient and non - responsive to P, and P inefficient and responsive to P respectively. The presence of some F_2 families with characteristics of the parents indicates that the genes for P efficiency and responsiveness to P were successfully transferred from the parents to the progenies .

There were other sorghum families that were P inefficient and non -responsive to P, and P efficient and responsive to P. These sorghum families possessed a recombination of the parental attributes. This indicates that independent assortment for P efficien cy and responsiveness to P occurred. The occurrence of recombinants which were both P efficient and responsive to P application is important in development of superior sorghum varieties. Such plants will be able to yield well at low P and even better when supplied with P. According to Corrales *et al.* (2007), high responsive by plants to P fertilizer application is an important characteristic for achieving high crop productivity.

The F_2 sorghum families segregated in both directions in P efficiency and re sponse to P application. Weidong *et al.* (2001) reported that P use efficiency showed continuous variation with segregation in both directions, suggesting polygenic inheritance pattern in wheat. Therefore results of this study suggests that P efficiency and responsive to P application are under polygenic inheritance. Therefore, further research should be done to have a better understanding of genetic control of both P efficiency and responsiveness to P. This information will be useful in guiding breeding aimed at development of low P tolerant sorghum varieties.

Conclusions

There was genetic variability for P-efficiency and responsiveness to P fertilizer application among the F_2 sorghum families which implied that P-efficiency and responsiveness to P application was successfully transferred from the parents MCSR L6 and MCSR N64 respectively, to the progenies. The occurrence of recombinants with combined attributes of the two parents indicates that P efficiency and responsiveness to P are independently inherited.

Acknowledgments

The financial support for this research was from SIDA -SAREC through the BIOEARN project. The research team under the BIOEARN project who provided sorghum seeds for this study is also gratefully acknowledged.

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