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LINEAR CORRELATION ANALYSIS AMONG GROWTH AND YIELD PARAMETERS OF SORREL AS AFFECTED BY SPACING AND WEEDING REGIME

Y B Kajidu, N. A. Gworgwor

Nigeria

Y B Kajidu

ABSTRACT

A study was conducted at faculty of agriculture teaching and research farm of university of Maiduguri located at (11°50'N: 13°10'E and 319 m above sea level) during the rainy seasons of 2009 and 2010 between June and September on Linear Correlation Analysis among Growth and Yield Parameters of Sorrel as affected by Spacing and Weeding Regime with the objective of determining the type of correlation existing among growth and yield parameters, growth at early stage and weed parameters, yield and weed parameters. The treatments consisted of 2 factors which were inter-row spacing and weed interferences which were laid out in a split-plot design. The inter row-spacing was in the main plot, and consisted of 3 inter-row spacings of 30 cm, 60 cm and 90 cm and intra-row spacing of 60 cm was maintained for all treatments. The weed interference was assigned to the sub-plot. These comprised 8 weed interference treatments; weed infested for 3, 6, and 9 weeks, and weed infested till harvest, and weed free for 3, 6, and 9 weeks and weed free till harvest. Parameters measured included Stand count per net plot, Number of leaves per plant, Plant height (cm), Fresh leaf yield per net plot (g), Dry leaf yield per net plot (g), Number of calyx per p1ant, Fresh calyx yield per net plot (g), Dry calyx yield per net plot (g), Number of branches per plant, Number of seeds per capsule, 1000 Seed weight (g), Seed yield per net plot (g), Weed Cover Scores, Weed Dry Matter per Net Plot (g). The results indicated that there were positive correlations among growth and yield parameters indicating that a good growth unaffected by weed infestation resulted in higher dry matter and yield of sorrel. However there was no correlation between growth at early stage and weed parameters. But there was negative correlation between yield and weed parameters later which also indicated that weeds directly affected yield of sorrel in a negative way.

Key words: Growth, Spacing, Weeding, Sorrel and Correlation

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INTRODUCTION

Sorrel *(Hibiscus sabdariffa* L.) is an important vegetable crop in northern and southern Nigeria (Alegbejo, 2000). The crop is recognized in the world at large for its value (vegetable, medicinal, beverage etc) and its increasing demand (Steve, 2003) and therefore warrants an urgent need for research in the aspect of yield increase.Sorrel is an important annual tropical dicotyledenous crop that belongs to the family of

Malvaceae. There are two basic types: green and brown-leaved crop types (Alegbejo, 2000). The crop is probably native to West Africa but now widely cultivated in the tropics of Africa and Asia (Steve, 2003). It tolerates fairly poor conditions (soil deficient in nitrogen, phosphorus, potassium, low moisture content), and is a short day plant (Alegbejo, 2000). In Nigeria the major areas of production are Kogi, Niger, Bauchi, Oyo, Kano, Jigawa, Yobe and Borno States (Aliyu, 1997). Its geographical distribution is found mainly in the Guinea and Sudan savanna zones of Nigeria. The green type is generally more common in the western part of the country while the brown or red is more prevalent in the Northern Guinea savanna (Alegbejo, 2000).Sorrel grows well in loamy and well drained soils. When grown for the calyx, it is preferable to grow sorrel in the mid wet season or towards the end of wet season. But when grown for the leaves it can be at any time. Sorrel is propagated by seed; it is usually drilled 3-4 seeds within row at 1 cm sowing depth. The tender leaves of the plant are used for making soup in the northern and southern states of Nigeria. More popularly the calyx of the red type is used nowadays as a beverage drink, it is partially boiled in hot water, strained and sugar is added to taste. The liquid is chilled and taken as a soft drink commonly called “zobo” drink. The calyx is also made into jellies, sauces, chutneys and preservers. The tender leaves and stalks are eaten as salad and are used as pot herbs for seasoning curry, the seed contains oil, and 4% citric acid (Alegbejo, 2000).Traditionally, preparation from various parts of the plant such as flowers, leaves, calyx and corolla are used as remedy for various illness (Onyenekwe, 1998). Roselle leaves are emollient and used as diuretic, sedative and refrigerant while the fruits are considered antisorbutic. Calyx infusion is considered diuretic, choleretic, intestinal antiseptic and mild laxative, refreshing and considered useful in bilious conditions, heart and nerve diseases, high blood pressure and calcified arteries. It is used to reduce/ameliorate hypertension (Onyenekwe, 1998). The soft fibres of the stem are used for coarse fabrics such as canvas and sacks (Dempsey, 1975).

Statement of the Problem Shippers (2000) reported that sorrel is grown mainly for its fresh calyx and is usually found either in long rows as a plant marking the border between plots or as individual plants in kitchen gardens. The crop is sown at a spacing of about 50 x 70 cm, with a wider spacing resulting in shorter plants with more branches and more fruits per plant. However, a narrowed spacing will give a greater fresh calyx weight/unit area. More so, there has not been any tangible report on the weed interference of this crop.

Objectives of the study

- To determine the type of correlation existing among growth and yield parameters
- To determine the correlation between growth at early stage and weed parameters.
- To determine the type of correlation existing among yield and weed parameters.

Effect of Spacing on Plant Growth

Kabura *et al.* (2003) reported that for the production of calyx of sorrel in the Sudan Sahelian region plant, of spacing of 60 x 30 cm should be encouraged. However maximum number of calyx and maximum dry weight of calyx per stand were generally greatest at wider spacing. Inter row spacing did not have any significant effect on growth and yield of tomato except in Kadawa in 1987/88 dry season where 30 and 40 cm spacing resulted in similar tomato fruit yields which were significantly higher than that of 60 cm spacing. Spacing of 30 cm also resulted in higher number of leaves than 60 cm spacing (Adigun *et al.*, 1994). In general, plant population at optimum allows for uniform product at harvest. Blasedale (1970) reported that increased plant population beyond optimum leads to competition for space, light and carbohydrate between the individual plants thereby giving rise to lower yields. Tenaw *et al.* (2011) in their report on effects of plant density, variety and weeding frequency on net economic benefit of sweet potato stated that high yield was attributed to increased plant density. Karaye and Yakubu (2005) reported that the response of weed growth and bulb yield of garlic indicated that the number of leaves per plant, weed growth and cured bulb yield responded significantly to intra row spacing and mulching and concluded that intra-row spacing of 10 cm should be adopted.

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Effect of Weed Association on Vegetable Crops

Results of weed association and spacing on soyabean in Sudan savanna region of Nigeria indicated that plant height, number of pods per plant and grain yield, increase with increase in number of weedings, whereas weed dry biomass decreased with increase in number of weedings (Sodangi *et al.,* 2006). El-Naim and Ahmed (2010) reported that weeding three times at 2, 4 and 6 weeks after sowing (WAS) was optimal for plant height, leaf area index, number of branches, number of calyx per plant, calyx diameter and calyx yield per unit area in their study to determine the effect of weed interference on growth and yield of two Roselle (*Hibiscus sabdariffa* L.) varieties under rainfed condition in North Kordofan of Sudan. Katung *et al.* (2000) reported that the fibre, seed yield of kenaf increased significantly with the length of weed free period. The plots kept weed free during the entire growth cycle produced significantly higher fibre yield and seed yields and are comparable to those kept weeds infested for 3 weeks after sowing. Period of weed interference had significant effect on crop vigour, where the highest weed cover score was recorded on plots kept weed infested for 12 WAS and more. Weed infestation up to 6 WAS and beyond depressed yields of kenaf. Similarly, Kuchinda *et al*. (1991) observed fibre yield and capsule reductions of 47.2% and 30.0% due to unrestricted weed growth in kenaf.

MATERIALS AND METHODS

The experiment was conducted at the Department of Crop Production Teaching and Research farm, Faculty of Agriculture University of Maiduguri, Maiduguri (11°50'N: 13°10'E and 319 m above sea level) during the rainy seasons of 2009 and 2010 between June and September. The physiochemical characteristics of the experimental site were: pH in water 6.43 slightly acidic, organic carbon 5.30 g/kg, organic matter 7.04 g/kg, available phosphorus 4.55 g/kg, available potassium 3.10 g/kg. Field texture is sandy loam with clay15.60%, sand 70.30% and silt 14.10% (Appendix 1) The research area is commonly characterized by growing sorrel as a border plant; either to protect their main crops or to mark border between two different farms. The crops grown previous year in the experimental area included pearl millet (*Pennisetum glaucum* L. R. Br.), sorghum (*Sorghum bicolor* L. Moench), cowpea (*Vigna unguiculata* L. Walp), and groundnut (*Arachis hypogaea* L.). Some major weeds that associate with crops in that area include *Ipomoea* spp, *Merremia aegyptia*, *Cenchrus biflorus* Roxb, and *Commelina benghalensis* among others. The most common methods of weed control are mainly hand weeding and use of herbicides.

Treatments and Experimental Design

The treatments consisted of 2 factors which were inter-row spacing and weed interferences which were laid out in a split-plot design. The inter row-spacing was in the main plot, and consisted of 3 inter-row spacings of 30 cm, 60 cm and 90 cm and intra-row spacing of 60 cm was maintained for all treatments. The weed interference was assigned to the sub-plot. These comprised 8 weed interference treatments; weed infested for 3, 6, and 9 weeks, and weed infested till harvest, and weed free for 3, 6, and 9 weeks and weed free till harvest. These treatments were replicated three times. The gross plot size was 3 m x 4 m (12 m^2) and sampling was done from the net plot of 2 m x 3 m (6 m^2).

Parameters measured

All weight parameters were based on (g) per net plot but later converted to kg/ha for the sake of analysis. These are: Stand count per net plot, Number of leaves per plant, Plant height (cm), Fresh leaf yield per net plot (g), Dry leaf yield per net plot (g), Number of calyx per p1ant, Fresh calyx yield per net plot (g), Dry calyx yield per net plot (g), Number of branches per plant, Number of seeds per capsule, 1000 Seed weight (g), Seed yield per net plot (g), Weed Cover Scores, Weed Dry Matter per Net Plot (g)

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) using Statistix 8.0® software (Analytical Soft ware, 2008). Simple correlation analysis was carried out on growth/ yield and weed parameters of sorrel.

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RESULTS

Linear Correlation Analysis: Correlation coefficient analysis among growth and yield parameters of sorrel as affected by spacing and weeding regime are presented in Tables 1 and 2.

Linear Correlation among growth and yield parameters in sorrel in 2009

Stand count of sorrel at harvest had highly significant positive correlation with the number of leaves per plant at harvest, plant height at harvest, the number of seed/capsule, fresh and dry calyx weight and seed yield, and highly significant negative correlation with weed cover score at 6 and 9 WAS, and weed dry matter (Table 1). Plant height at harvest had highly significant negative correlation with weed cover score at 6 and 9 WAS but highly significant positive correlation with all other parameters (number of calyx per plant, number of seed per capsule, number of branches per plant, fresh and dry calyx, fresh and dry leaf weight and seed yield). Weed cover score at 6 and 9 WAS had highly significant negative correlation with the number of calyx per plant, the number of branches per plant, fresh and dry calyx weight and seed yield. Weed dry matter had highly negative correlation with fresh leaf yield but highly significant positive correlation with dry calyx weight and seed yield. Fresh calyx weight had highly significant positive correlation with fresh and dry leave yield, weed dry matter, dry calyx and seed yields.

Seed yield had highly significant positive correlation be with plant height at harvest, the number of seed per capsule, the number of branches per plant, fresh and dry calyx weight and weed dry matter but negatively correlated with weed cover score at 6 weeks and dry leaf weight at 8 weeks (Table 1).

Linear Correlation among Growth and Yield Parameters of Sorrel in 2010

Stand count at harvest had highly significant positive correlation with number of leaves per plant at harvest, plant height at harvest, number of seed per capsule fresh and dry calyx yield and seed yield, but highly significant negative correlation with weed cover score at 6 and 9 WAS and weed dry matter (Table 2). Plant height at harvest had highly significant negative correlation with weed cover score at 6 and 9 WAS but highly significant positive correlation with number of calyx per plant, number of seeds per capsule, the number of branches per plant, fresh and dry leaf yield, fresh and dry calyx yield and weed dry matter. Weed cover score at 6 and 9 WAS had highly significant negative correlation with number of calyx per plant, number of branches per plant, fresh and dry leaf yield, fresh and dry calyx yield, and seed yield. Weed dry matter had positive correlation with weed cover score at 9 WAS, highly negative correlation with fresh leaf yield, dry calyx yield and seed yield. Fresh and dry calyx yield had highly positive correlation with seed yield. Seed yield was highly significantly positively correlated with all parameters except weed dry matter, dry leaf yield and weed cover score at 6 and 9 WAS having negative correlations (Table 2).

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Table 1: Correlation coefficient among growth and yield parameters of Sorrel in 2009

	LVS4	SC2	SCH	LVSH	PH4	PHH	WC6	WC9	CLXPP	Seedcap	BRPP	Fclxwgha	DLW8kgha	Wdm kg ha	Fly8kgha	Dclxwkgha
LV54	1.000															
SC2	0.080*	1.000														
SCH	0.176**	0.648***	1.000													
LVSH	0.006	-0.069	0.409***	1.000												
PH4	0.539***	0.032	0.117	0.047	1.000											
PHH	-0.021	-0.055	0.466***	0.738**	0.039	1.000										
WC6	-0.142	-.0.033	-0.329***	-0.385	-0.187**	-0.519***	1.000									
WC9	-0.174**	-0.003	-0.492***	-0.604***	-0.090	-0.736**	0.596***	1.000								
CLXPP	0.140	-0.381** *	0.106	6.527***	0.188**	0.593***	-0.403***	-0655***	1.000							
Seedcap	-0.007	-0.037	0.414***	0.536***	0.100	0.602***	-0.302***	0.487***	0.566***	1.000						
BRPP	0.221**	-0.318** *	0.167*	0.464***	0.323***	0.577***	-0.049***	-0.610***	0.694***	0.642***	1.000					
Fclxwkha	0.277***	0.283***	0.720***	0.528***	0.157	0.594***	-0.659***	-0.757***	0.447***	0.440***	0.421***	1.000				
DLW8kgha	-0.067	-0.140	0.194**	0.454***	0.065	0.580***	-0.696***	-0.576***	0.519***	0.386***	0.475***	0.550***	1.000			
WDMkgha	-0.235**	-0.133	-0.562***	-0.477***	-0.231**	0.652***	0.687***	0.663	0.573***	-0.496***	0.591***	0.722***	-0.553***	1.000		
FLY8kgha	-0.032	-0.161	0.220**	0.515***	0.090	0.577***	-0.751***	-0.610	0.562***	0.397***	0.508***	0.605***	0.926***	-0.576***	1.000	
DCLxwkgh a	0.382***	0.263***	0.597***	0.401***	0.202**	0.432***	-0.536***	-.0616	0.301***	0.272***	0.349***	0.841***	-0.394***	0.569***	0.456***	1.000
Sdykga	0.267**	0.204**	0.629***	0.519***	0.162*	0.553***	-0.632***	-0.707	0.519***	0.405***	0.451***	0.853***	-0.527***	0.696***	0.591***	0.706***

*: significant at 5% level of probability
**: significant at 1% level of probability
***: significant at 0.1% level of probability

Key

Lvs4	-	Number of leaves/plant at 4 weeks	Seedcap	-	Number of seeds/capsule
SC2	-	Stand count at 2 WAS	Brpp	-	Number of branches/plant
SCH	-	Stand count at harvest	Fclwkgha	-	Fresh calyx weight kg/ha
LVSH	-	Number of leaves plant at harvest	Dlw8kgha	-	Dry leave yield at 8 WAS kg/ha
PH4	-	Plant height at 4 WAS	Wdm	-	Weed dry matter kg/ha
WC6	-	Weed cover at 6 WAS	Fly8kgha	-	Fresh leaf yield kg/ha
WC9	-	Weed cover at 9 WAS	Dclxwkg/ha	-	Dry calyx weight kg/ha
CLXPP	-	Number of calyx/plant	Sdykg/ha		-Seed yield kg/ha

Table 2: Correlation coefficient among growth and yield parameters of Sorrel in 2010

	LVS4	SC2	SCH	LVSH	PH4	PHH	WC6	WC9	CLXPP	Seedcap	BRPP	Fclxwgha	DLW8kgha	Wdm kg ha	Fly8kgha	Dclxwkgha
LV54	1.000															
SC2	0.042	1.000														
SCH	0.160*	0.62***	1.000													
LVSH	0.075	-0.088	0.411***	1.000												
PH4	0.508	-0.019	0.090	0.115	1.000											
PHH	-0.014	-0.039	0.528***	0.722***	0.047	1.000										
WC6	-0.128	-0041	-0449***	-0460***	-0.178**	-0.605***	1.000									
WC9	-0.220**	0.001	-0.526***	-0.624***	-0.084	-0.773***	0.696***	1.000								
CLXPP	0.142	-0.385 ***	0.129	0.539***	0.185**	0.569***	-0.475***	-0.646***	1.000							
Seedcap	0.014	0.012	0.491***	0.599***	0.123	0.649***	-0.429***	-0.512***	0.546***	1.000						
BRPP	0.248**	-0.361***	0.128	0.534***	0.330***	0.564***	-0.437***	-0.602***	0.684***	0.613***	1.000					
Fclxwkgha	0.259***	0305***	0.778***	0.516***	0.078	0.641***	-0.679***	-0.774***	0.422***	0.515***	0.371	1.000				
DLW8kgha	-0.113	-0.205***	0.206**	0.467***	0.018	0.617***	-0.644***	-0.606***	0.568***	0.439***	0.483***	0.478	1.000			
Wdmkgha	-0.217**	-0.141	-0.564***	-0.547***	-0.220***	0.698***	0.774***	0.569**	0.555***	0.533	-0.569***	-0.714***	-0.565***	1.000		
Fly8kgha	0.044	0.232***	0.245***	0.543***	0.051	0.630***	-0.732***	-.0.682***	0.630***	0.460***	0.547***	0.548***	0.941***	-0.627***	1.000	
DCLxwkgha	0.422***	0.261***	0.624***	0.432***	0.170**	0.438***	-0.530***	-.0632***	0.274***	0.335***	0.330***	0.836***	-0.311***	-0.561***	0.402***	1.000
Sdykga	0.208**	0.220**	0.709***	0.530***	0.079*	0.645***	-0.660***	-0.758***	0.517***	0.506***	0.399***	0.886***	-0.507***	-0.710***	0.572***	0.705***

*: significant at 5% level of probability
**: significant at 1% level of probability
***: significant at 0.1% level of probability

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Key

Lvs4	-	Number of leaves/plant at 4 weeks	Seedcap	-	Number of seeds/capsule
SC2	-	Stand count at 2 WAS	Brpp	-	Number of branches/plant
SCH	-	Stand count at harvest	Fclwkgha	-	Fresh calyx weight kg/ha
LVSH	-	Number of leaves plant at harvest	Dlw8kgha	-	Dry leave yield at 8 WAS kg/ha
PH4	-	Plant height at 4 WAS	Wdm	-	Weed dry matter kg/ha
WC6	-	Weed cover at 6 WAS	Fly8kgha	-	Fresh leaf yield kg/ha
WC9	-	Weed cover at 9 WAS	Dclxwkg/ha	-	Dry calyx weight kg/ha
CLXPP	-	Number of calyx/plant	Sdykg/ha	-	Seed yield kg/ha

DISCUSSIONS

Correlation Coefficient among Growth and Yield Parameters in sorrel

In both years similar correlations were observed between the growth and yield parameters of sorrel such as stand count at harvest, number of leaves per plant at harvest, plant height at harvest, fresh and dry leave weight, fresh and dry calyx yield and seed yield. The growth parameters had positive correlations with the yield parameters indicating that a good growth unaffected by weed infestation, equally resulted in higher dry matter and yield of sorrel. However there was no correlation between growth at early stage and weed parameters such as weed cover score and weed dry matter; this was probably because weeds have not grown much at the early stage of the crops' growth. But there was negative correlation between yield and weed parameters later which also indicated that weeds directly affected yield of sorrel in a negative way when left to grow unchecked and a positive effect when removed at the right time during the growth stage of the crop. This result agrees with Sodangi *et al*. (2006) where he reported similar findings.

Conclusion

- There is positive correlations among growth and yield parameters indicating that a good growth unaffected by weed infestation resulted in higher dry matter and yield of sorrel.
- However there was no correlation between growth at early stage and weed parameters.
- But there was negative correlation between yield and weed parameters later which also indicated that weeds directly affected yield of sorrel in a negative way.

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