correlated positively and significantly with number of seeds/row (r = .307**). Result also showed that number of seeds/row had positive and significant correlation with oil (r = .320**). Negative and significant correlation was observed between amylose and amylopectin (r = -1.000**).

The result obtained on correlation analysis of the 71 genotypes after the second year evaluation is as presented in Table 2. Plant height correlated positively and significantly with ear height (r = .829**), days to 50% tasselling and silking (r = .376** and .357**) and number of tassels (r = .481**). Cob length had positive and significant correlation with cob circumference (r = .351**) and number of seeds/row (r = .425**). Cob circumference correlated positively and significantly with number of rows/cob (r = .512**) while number of rows/cob correlated positively and significantly with number of seeds/row (r = .399**). The correlation analysis also indicates that 100-seed weight had positive and significant correlation with kernel density (r = .745**).

Table 1: Correlation co-efficients of the agronomic and chemical traits in 2013 cropping season

	Plant ht.	Ear ht.	50% tas-selling	50% silking	Tassel No./ plant	Ear No./ Plant	Cob length	Cob circf.	Row No./ cob	Seed No. /row	100 seed wt.	Kernel dens.	Protein	Lysine	Oil	Amy-lose	Amy-lopec
Plant ht.	I																
Ear ht.	.941**	I															
50% tassel.	.720**	.730**	I														
50% silk.	.746**	.734**	.904**	I													
Tassel no.	.672**	.671**	.667**	.690**	I												
Ear no.	.254*	.219	.195	.238*	.053	I											
Cob length	.716**	.664**	.544**	.523**	.414**	.229	I										
Cob circf.	.395**	.296*	.208	.335**	.184	.147	.242*	I									
Row no.	.424**	.405**	.375**	.359**	.220	.012	.223	.478**	I								
Seed no.	.608**	.579**	.432**	.432**	.352**	.203	.708**	.094	.307**	I							
100seed wt	-.106	-.103	-.174	-.164	-.272*	.122	.050	-.048	-.049	-.013	I						
Kernel den	-.076	-.131	-.112	-.093	-.144	-.001	-.125	.009	-.153	-.092	.089	I					
Protein	-.127	-.125	-.204	-.162	-.156	.031	-.159	-.175	-.015	-.130	.184	-.008	I				
Lysine	.006	-.035	.024	.034	.049	.031	-.066	.167	-.138	-.100	-.034	.141	-.529**	I			
Oil	.147	.167	.157	.085	.046	.126	.170	-.088	.166	.320**	.003	-.239*	-174	.012	I		
Amylose	-.286*	-.302*	-.097	-.143	-.145	-.118	-.056	-.187	-.101	-.144	.129	.083	.067	-.014	.170	I	
Amylopec.	.286	.303*	.097	.143	.145	.118	.055	.187	.100	.144	-.129	-.082	-.066	.016	-.169	-1.000	I

*****Correlation is significant at 5% level of probability (P = 0.05)
**Correlation is significant at 1% level of probability (P = 0.01)

Table 2: Correlation co-efficients of agronomic traits for the 71 genotypes evaluated in 2014 cropping season

	Plant ht.	Ear ht.	50% tassel-ing	50% silking	Tassel No./ Plant	Cob length	Cob circf.	Row No./ Cob	Seed No. /row	100 seed wt.	Kernel dens.
Plant ht.	I										
Ear ht.	.829**	I									
50% tassel.	.376**	.303**	I								
50% silk.	.357**	.344**	.842**	I							
Tassel no.	.481**	.569**	.342**	.387**	I						
Cob length	.032	.061	.234**	.298*	.003	I					
Cob circf.	-.085	.014	-.138	-.024	-.095	.351**	I				
Row no.	.015	.030	-.132	-.074	-.006	.095	.512**	I			
Seed no.	-.054	-.001	-.065	.015	-.049	.425**	.538	.399**	I		
100seed wt	.206	.127	.103	.147	.098	-.001	-.165	-.067	.037	I	
Kernel den	.202	.143	.083	.082	.050	-.153	-.292	.042	-.047	.745**	I

*****Correlation is significant at 5% level of probability (P = 0.05)
**Correlation is significant at 1% level of probability (P = 0.01)

4. Discussion

Correlation analyses of agronomic and chemical characteristics after 2013 planting season revealed significant and positive correlations in most agronomic traits. In both two planting seasons, plant height had positive correlation with yield attributes such as number of tassels/plant, number of ears, number of rows/cob and number of seeds/row, cob length and circumference. The result which we found on this research is in agreement with Alvi*et al*. [21], Akbar *et al*. [22] and Bocanski*et al*. [23] who found positive correlations between grain yield and morphological traits of plants. In contrast, Sreckov*et al*. [12] reported negative values of coefficient of correlations between grain yield and plant height.

However, there was no significant correlation between agronomic and chemical characteristics measured, especially the yield components, except number of seeds per row and

oil which correlated positively. Obi and Onyishi[24] found that selection of increased chemical constituents in maize such as protein, oil, amylose and amylopectin does not affect the agronomic traits such as plant height, ear height, 100-seed weight, kernel density and days to 50% silking of the crop. Rainji*et al*. [25] and Muhammad *et al*. [26] found oil content to be significantly and positively correlated with agronomic trait such as plant and ear heights. However, Okporie and Oselebe[27] found that oil content and kernel weight were uncorrelated in random-mated population selected for oil content.

Positive association found between number of seed/row and kernel oil from this study is in agreement with Salem *et al*. [28] and Sreckov*et al*. [12] who reported similar results.Oil content was in positive correlations with cob length and 100-kernel weight, in both planting seasons and with plant height and kernel row number and ear height. Our results are similar to the findings of Sreckov*et al*. [29] who studied genetic potential of these two populations after 16 cycles of phenotypic recurrent selection. At 568/II testcrosses they found low positive relation between kernel oil content and ear length and kernel row number. They also found positive correlation between oil content and plant height and 100–kernel weight. Also, contrary to our results they established positive correlations between kernel oil content and ear height.

Also, significant and negative correlation was observed between amylose and amylopectin. Increase in the amylopectin content must have affected the amylose content. Obi and Okporie[30] reported that while the percentage of amylose increased, the percentage of amylopectin decreased and vice versa. The change they observed was followed by changes in the amount of oil and protein produced. There was a corresponding decrease in endosperm weight and increase in pericarp and germ weight resulting in concurrent increase in oil and protein. The negative but non-significant correlation between protein and lysine implies that more and effective selection pressure could cause them to be uncorrelated.

Since no significant relationship existed between chemical characteristics and most agronomic traits, it indicated that good chemical quality such as high protein as well as high oil maize can be bred and selected without necessarily affecting the agronomic traits such as plant and ear heights. This result is contrary to the work by Obi and Okporie[30] and Obi and Onyishi[31] who found oil content to be significantly and positively correlated with plant and ear heights. This departure may be due to sample size and/or source populations. The results also showed that source varieties affected the correlations and made generalization of some of the results difficult. Apparently, increase in the chemical constituents (protein, lysine, oil, amylose and amylopectin) under selection appeared not to have adversely affected the agronomic traits measured.

5. Conclusion

Since no significant relationship existed between chemical characteristics and most agronomic traits, it indicated that good chemical quality such as high protein as well as high oil maize can be bred and selected without necessarily affecting the agronomic traits such as plant and ear heights.

References

[1] I.U. Obi. What Have I Done as an Agricultural Scientist? Achievements, Problems and Solution Proposals. An Inaugural Lecture of the University of Nigeria, Nsukka. Printed by UNN Press Ltd,2006.

[2] C.C. Laurie, S.D. Chasalow, J.R. Ledeaux, R.M.C. Carrolla, D. Bush, B. Hange, C. Lai, D. Clark, T.R. Rocheford and J.W. Dudley. The genetic architecture of response to long-term artificial selection for oil concentration in the maize kernel. *Genetics*, 168: 2141-2155, 2004.

[3] E.O. Okporie and I.U. Obi. Estimation of genetic gains in protein and oil of eight populations of maize (*Zea mays* L.) after three cycles of reciprocal recurrent selection. *J. Sci. Agric., Food Tech. Environ*., 2: 40-45, 2002.

[4] A.K.K. Achakzai. Effect of water stress on cations accumulation by maize seedlings (*Zea mays* L.). *J. Chem. Soc. Pak.*, 30(2): 271-275, 2008.

[5] C. Lucas. Regulation of floury2-mRFP expression in response to long term selection for grain protein concentration in maize: University of Illinois at Urbana-Champaign: 1-77 p, 2010.

[6] M. Scott, J. Edwards, C. Bell and J. Schussler. Grain composition and amino acid content in maize cultivars representing 80 years of commercial maize varieties. *Maydica*: 417-423, 2006.

[7] A. Darrigues, C. Buffard, K.R. Lamkey and M.P. Scott. Variability and genetic effects for tryptophan and methionine in commercial maize germplasm. *Maydica* 50: 147 – 156, 2005.

[8] I.U. Obi.*Maize, Its Agronomy, Diseases, Pest and Food Values*. Optimal Computer Solutions Ltd. Enugu, Publishers. 76 Agbani Road Enugu, Nigeria, XXVIII +, pp: 206, 1991.

[9] M.H. Abou-Deif, B.B. Mekki, E.A.H. Mostafa, R.M. Esmailand S.A.M. Khattab. The Genetic Relationship Between Proteins, Oil and Grain Yield in Some Maize Hybrids. *World Journal of Agricultural Sciences* 8 (1): 43-50.2012.

[10] L.O. Medici, S.A. Gaziola, V.A. Varisi, J.A.C. Paula, R.R. Ferreira and R.A. Azevedo. Diallelic analysis for lysine and oil contents in maize grains. *Scientia Agricola*, 66: 204-209, 2009.

[11] M. Cervantes, F. Copado, S. Espinoza, M. Cervantes and N. Torrentera. Prediction of the amino acid content in wheat based on the crude protein value. Proceedings, Western Section, American Society of Animal Sci., pp: 54, 2003.

[12] Z. Sreckov, A. Nastastic, J. Bocanski, I. Djalovic, M. Vukosavljevand B. Jockovic. Correlation and path analysis of grain yield and morphological traits in test-cross populations of maize. *Pak. J. Bot.*, 43: 1729-1731, 2011.

[13] P. Liu, F. Xie, M. Li, X. Liu, L. Yu, P. J. Halley and L. Chen. *Carbohydrate Polymers*, 85, 180–187, 2011.

[14] A. Mittelmann, J.B. Miranda Filho, G.J.M. Lima, C. Hara-Klein, R.M. Silva and R.T. Tanaka. Diallel analysis of oil content in maize. RevistaBrasileira de Agrociencia, 12: 139-143, 2006.
[15] FDALR. Reconnaissance Soil Survey of Anambra State, Nigeria. Soils Report FDALR, 1985.
[16] D. Pearson. The Chemical Analysis of Foods. 7th Edn. Churchill Livingstone Pub. Co. London and New York, pp: 575, 1976.
[17] I.U. Obi. Application of 2,4,6, - Trinitrobenzene – 1 – Sulphuric Acid (TNBS) Method for the determination of available lysine of maize seed. *Agric.Biol. Chem.* 46 (1): 15-20, 1982.
[18] AOAC. 1995. Association of Official Analytical Chemists: Official Methods of Analysis. 16th Ed. Washington D.C. USA.
[19] R. Baker. Black –layer development. *World farming* 15: 14 –19, 1973.
[20] I.U. Obi. Introduction to Regression, Correlation and Covariance Analysis (with worked examples). Printed and bound in Nigeria by Optimal International Ltd., 113 Agbani Rd. Enugu. 2nd Ed. Pp. 105, 2011.
[21] M.B. Alvi, M. Rafique, M.S. Tariq, A. Hussain, T. Mahmood and M. Sarwar. Character association and path coefficients analysis of grain yield and yield components maize (*Zea mays* L.). *Pak. J. Biol. Sci.*, 6(2): 136-138, 2003.
[22] M. Akbar, M.S, Shakoor, A. Husein and M. Sarwar. Evolution of maize 3–way crosses through genetic variability, broad sense heritability, characters association and path analysis. *J. Agric.Res.*, 46(1): 39-45, 2008.
[23] J. Bocanski, Z. Sreckov and A. Nastasic. Genetic and phenotypic relationship between grain yield and components of grain yield of maize (*Zea mays* L.). *Genetika*, 41(2): 145-154, 2009.
[24] I. U. Obiand G.C. Onyishi. Development of synthetics of high protein, oil, amylose, amylopectin and low oil maize (*Zea mays* L.) from two cycles of reciprocal recurrent selection. Ph.D thesis submitted to the department of Crop Science, UNN. Unpublished, 1992.
[25] R. Rajni, K.R. Sarkar and D. Singh. Correlations and regressions among oil content, grain. Yield and yield components in maize. *Ind. J. Agric. Sci.*, 53: 285-288, 1983.
[26] S. Muhammad, A. Muhammad, A. Muhammad and M. Atif. Comparative evaluation and correlation estimates for grain yield and quality attributes in maize. *Pak. J. Bot.*, 40(6): 2361-2367, 2008.
[27] H. O. Oselebeand E. O. Okporie. Correlation of protein and oil contents with five agronomic characters of maize (*Zea mays* L.) after three cycles of reciprocal recurrent selection. *World J. Agric. Sci.*, 3(5): 639-641, 2007.
[28] M. Sallem, M. Ahsan, M. Aslam and A. Majeed. Comparative evaluation and correlation estimates fog grain yield and quality attributes in maize. *Pak. J. Bot.*, 40(6): 2361-2367, 2008.
[29] Z. Sreckov, J. Bocanski and M. Ivanovic. Genetic and phenotypic correlations between oil content and morphological traits in high oil maize population NSU1. *Genetika*, 39(2): 103-112, 2007.
[30] E. O. Okporie and I. U. Obi. Development of acid tolerant, high yielding and high nutritional maize variety after two years of mass selection. *Sci. of Agric food tech and Envir.* Vol.4 pp 23 – 30, 2004.
[31] I. U. Obi and G.C. Onyishi. Development of high protein population of maize (*Zea mays* L.) from two cycles of reciprocal recurrent selection. *Samaru J. Agric. Res.*, 11: 63 – 68, 1994.