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Correlation of Protein and Oil Contents with Five Agronomic Characters of Maize (*Zea mays* L.) After Three Cycles of Reciprocal Recurrent Selection

E.O. Okporie and H.O. Oselebe

Department of Crop Production and Landscape Management, Ebonyi State University, Abakiliki, Nigeria

Abstract: A correlation analysis study was conducted with eight varieties of maize (*Zea mays* L.): Nsukka High Quality-Yellow Early (NHQ-YE); Nsukka High Quality-White Early (NHQ-WE); Nsukka High Quality-Yellow Late (NHQ-YL); Nsukka High Quality-White Late (NHQ-WL); Nsukka Quality Maize-Yellow Early (NQM-YE); Nsukka Quality Maize-Yellow Late (NQM-YL); Nsukka Maize-Yellow Early (NM-YE) and Nsukka Maize-Yellow Late (NM-YL); developed after three cycles of reciprocal recurrent selection, to find out the association of increasing protein and oil contents with five agronomic characters. The result showed that the 100-kernel weight and kernel density which predict yield components and days to 50 percent silking which predicts the maturity time of maize plants were independently associated with protein and oil contents in all the source varieties. This indicates that, these chemical constituents of maize can be increased or decreased and selected for without adversely affecting the five agronomic characters.

Key words: Correlation · protein · oil · recurrent selection

INTRODUCTION

Maize (*Zea mays* L.) grains, nutritionally, is known to be predominantly carbohydrate but has small proportions of protein, oil, amylose, amylopectin and other minerals [1]. These constituents can be altered genetically when effective breeding methods are employed. Recurrent selection method has been among the most effective and successful methods employed in the maize improvement programs [2, 3].

Maize breeders suspect that kernel protein and oil content may be negatively correlated with yield. According to Obi [3], it has not been possible in combining nutritional quality with yield probably because of the reduction of starch content in the grains. Panthee *et al*. [4], pointed out that there exists an inverse relationship between seed protein and oil concentration, making it difficult to improve both traits simultaneously. If these statements are true, then maize breeders that are interested in developing agronomically good varieties with high nutritional quality are faced with formidable task. However, several researchers have paved the way toward simultaneous selection of high quality and high yielding crop varieties [5-7], working independently, have developed crops of high quality combined with high yield. Also Okporie and Obi [1], Obi and Onyishi, [8] and Jaya and Rao [9], all have at one time established the fact that protein and oil contents of cereals are positively correlated with yield. Rajni Raman *et al*. [10] found oil content to be significantly and positively correlated with 100-kernel weight, plant height, ear height and grains yield. Therefore, there would be no serious barrier in selecting for both high protein and oil.

The objective of this study, therefore, is to estimate degree of relationship, that is, the correlation between protein and oil and plant and/or ear heights, 100-kernel weight, kernel density and days to 50 percent silking so as to provide information that would guide the choice of parents for developing synthetics or hybrids with high protein and oil.

MATERIALS AND METHOD

Eight varieties: Nsukka High Quality-Yellow Early (NHQ-YE), Nsukka High Quality-White Early (NHQ-WE), Nsukka High Quality-Yellow Late (NHQ-YL), Nsukka High Quality-White Late (NHQ-WL), Nsukka Quality Maize-Yellow Early (NQM-YE), Nsukka Quality Maize-Yellow Late (NQM-YL), Nsukka maize-Yellow Early (NM-YE) and Nsukka Maize-Yellow Late (NM-YL) developed from the 3rd cycle of reciprocal recurrent selection at the University of Nigeria research farm, Nsukka, were used for

Corresponding Author: Dr. E.O. Okporie, Department of Crop Production and Landscape Management, Ebonyi State University, Abakiliki, Nigeria

the study. The associations between protein and oil and plant height, ear height, 100-kernel weight, kernel density and 50% silking were studied during the evaluation trails of the varieties. The Design was Randomized Complete Block (RCBD) with three replications. The plant spacing was 25cm within row and 75cm between rows at one plant per hill, giving a plant population of 53,333 per hectare. Harvesting was done at 129 days from planting, when the plants reached physiological maturity using black layer formation as an index of maturity [3].

The protein content was determined by the Micro-Kjeldahl method described by Pearson [11]. While the oil content was determined with the Soxhlet's extractor as described by Anon [12].

Correlations were studied between protein and oil and five characters, viz., plant height, ear height, 100-kernel weight, kernel density and days to 50 per cent silking and correlation coefficients were determined [13].

RESULTS

Correlations between protein and oil contents and plant height, ear height, 100-kernel weight, kernel density, days to 50 percent silking are shown in Table 1 and 2, respectively. The protein content showed positive and significant correlations with plant and ear heights only in Nsukka High Quality-White Late (NHQ-WL). There were non-significant correlations between protein content and 100-kernel weight, kernel density, days to 50 percent silking in all the eight source varieties.

The results in Table 2 show that oil content was positively and significantly correlated with plant and ear heights and days to 50 percent silking in Nsukka High Quality-Yellow Early (NHQ-YE) and in Nsukka Quality Maize-Yellow Early (NQM-YE) for ear height. On the other hand, negative significant correlation was obtained between oil content and days to 50 percent silking in Nsukka High Quality-White Early (NHQ-WE). However, six source varieties out of eight varieties used showed negative but non-significant correlations between oil content and 100-kernel weight.

Table 1: Correlations between protein content and agronomic characteristics in maize

Source population	Plant Height	Ear height	100-kernel weight	Kernel density	Days 50% silking
NHQ-YE	r = 0.346	r = 0.182	r = 0.198	r = 0.115	r = 0.028
NHQ-YL	r = 0.460	r = 0.338	r = -0.206	r = 0240	r = -0.036
NHQ-WE	r = 0.230	r = 0.179	r = 0.195	r = 0.138	r = 0.419
NHQ-WL	r = 0.545*	r = 0.535*	r = 0.315	r = 0.214	r = 0.216
NQM-YE	r = 0.397	r = 0.243	r = 0.050	r = 0.062	r = 0.173
NQM-YL	r = 0.385	r = 0.098	r = 0.098	r = 0.458	r = 0.424
NM-YE	r = 0.003	r = 0.021	r = 0.439	r = 0.058	r = 0.466
NM-YL	r = 0.183	r = 0.194	r = 0.404	r = 0.402	r = 0.113

* = Significant at 5% level of probability

Table 2: Correlations between oil content and agronomic characteristics in maize

Source population	Plant Height	Ear height	100-kernel weight	Kernel density	Days 50% silking
NHQ-YE	r = 0.608*	r = 0.663*	r = 0.248	r = 0.329	r = 0.556*
NHQ-YL	r = 0.132	r = 0.027	r = -0.410	r = 0.423	r = -0.052
NHQ-WE	r = 0.079	r = 0.051	r = -0.196	r = 0.261	r = -0.746*
NHQ-WL	r = 0.086	r = 0.066	r = 0.158	r = 0.223	r = 0.104
NQM-YE	r = 0.215	r = 0.553*	r = -0.010	r = 0.001	r = 0.013
NQM-YL	r = 0.352	r = 0.491	r = -0.247	r = 0.141	r = 0.338
NM-YE	r = 0.074	r = 0.224	r = -0.298	r = 0.257	r = 0.411
NM-YL	r = 0.103	r = 0.401	r = -0.462	r = 0.217	r = 0.180

* = Significant at 5% level of probability

DISCUSSION

The positive and significant correlation observed between protein and plant heights and also ear heights. Oil and plant height, ear height and days to 50 percent silking; suggest that as protein or oil was increased, plant and ear height increased, also as oil was increased days required for maturity increased. The implication of this scenario is that, to develop agronomically short, early maturing maize varieties with high oil content will be practically impossible because the genes controlling the agronomic traits are related and linked with that of the oil. On the other hand, negative and significant correlations observed in oil and days to 50 percent silking suggest that as any of the constituents was increased, days required for maturity decreased.

Similarly, the results showed non-significant relationship between protein and oil with 100-kernel weight and kernel density. This indicates that the above constituents of maize can be increase through reciprocal recurrent selection procedures without sacrificing the kernel weight or size at least to the degree that reduction in kernel size affects yield. This observation agreed with that reports by Okporie and Obi [5], Okporie and Obi [1], Obi and Onyishi, [8], Rajni Raman *et al*. [10] and Jaya *et al*. [14], they found that protein and oil contents and kernel weight were not correlated in random-mated population selected in protein content. Presumably, the percentage increase in protein and oil content in the selected populations during the study was brought about

either by increasing oil content of the embryo, or by increasing its absolute size, rather than by reducing endosperm size. If decreased endosperm size has been found to be associated with higher protein and oil percentages, then difficulty might be expected for breeders who would attempt to develop high protein and oil maize of acceptable seed weight or size.

Since no significant relationship existed between protein and oil or plant height in seven out of the eight populations, it indicates that high protein as well as high oil maize can be bred without affecting the maturity date or adversely affecting the plant and ear heights. This result is contrary to the work reported by Okporie and Obi [5] and Obi and Onyishi, [8] who found oil content to be significantly and positively correlated with plant and ear heights. This departure may be due to difference in 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 constituents (high protein and oil) under selection appeared not to have adversely affected the agronomic traits measured.

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