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Correlation between oil Content and Yield of Some early Maturing Soybean (*GLYCINE MAX* (L.)MERILL) Genotypes in Keffi, Nasarawa State

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Abstract— *Soybean meals and oils are very essential for human and animal health. Six varieties of Soybeans were evaluated to determine their variability in oil content as well as the correlation between oil content and yield parameters. The study was carried out during the rainy season of 2015 at the Botanical garden of the Department of Biological Sciences, Plant science and Biotechnology unit farm of Nasarawa State University, Keffi. The experiment was laid out in Randomized complete block design (RCBD) with three replications. Data was collected on agronomic characters such as days to emergence, days to 50% flowering, plant height, number of leaves, stem diameter, grain yield, seed weight , number of flowers, leaf area and oil content per a hundred grams of seeds. The results from these data were analyzed using ANOVA and correlation analysis. All of the analyzed traits varied significantly (P<0.05) between varieties. The variety TG × 1989 – 45F had the highest weight per plot with a mean of 3733 while TG ×1990 – 21F had the lowest mean as 1000g. It was observed that Variety TG×1989 – 42F had the highest mean for oil content (17.0ml). Oil content showed a positive correlation with number of pods r = 0.410, weight with pods r = 0.3406, weight without pods r = 1, number of seeds per pod r =0.9162* and Grain yield r = 0.215*. Based on this study soybean varieties TG ×1989 – 45F is recommended for farmers in Keffi area interested in high grain yield and oil content, respectively.*

***Keywords*— correlation, early maturing, oil content, soybean, yield**

I. INTRODUCTION

Soybean cultivation in Nigeria has expanded as a result of its nutritive and economic importance and diverse domestic usage. It is also a prime source of vegetable oil in the international market (Dashiel, 1993). The crop can be successfully grown in many states in Nigeria using low agricultural input. Annually, a good number of the world's total soybean production is processed .into different types of soybean meal and oil (Djekic*et al*., 2013). These meals and oils are very essential for child and adult health alike. Apart from human consumption, soybean is used for the production of nutritious animal feeds of different kinds in the market.

The importance of soybean in food security especially for the poor in Nigeria cannot be overemphasized. It is the best source of plant protein, substituting the animal-protein sources, which are usually inadequate in supply for poor households (Seyi, 2014).

Previous studies in different parts of the world suggest various plant traits which should be considered to be most important while selecting soybean genotypes for higher seed yield and oil content (Ashraf *etal*., 2012). Soybean breeders suspect that oil content is negatively correlated with yield (Babka*et al*., 2003).

An understanding of the relations among various characters with seed yield is essential so as to find appropriate selection criteria. Correlation studies is initiated with the objective of observing the mutual relationship of different morphological characters and also their contribution to yield parameters (Amsalu *et al*., 2014). Quite often, characters are correlated and selection for one character may lead to either positive or negative response in the other characters. This response can be predicted if the correlation and heritability of the characters are known (Morakinyo, 1996). It is a challenge to farmers and breeders to select specific varieties to use when planting for either seed yield, oil content or both. This serves as a problem and a foundation for undergoing this research. This study was aimed at evaluating the correlation between oil content and seed yield parameters of soybean (*Glycine max* (L.) Merill) in Keffi, Nasarawa State, Nigeria.

II. MATERIALS AND METHODS

2.1 Study Area

The field experiment was carried out during the rainy seasons of 2015 at the Botanical garden of the Department of Biological Sciences, Plant Science and Biotechnology unit farm of Nasarawa State University, Keffi. Nasarawa state is located 8°32′N 8°18′E in the Guinea Savannah Zone of Nigeria and annual rainfall figures range from 1100 mm to about 1600 mm.

2.2 Sample Collection

Six varieties comprising of three early maturing varieties with maturity dates ranging between 100 to 115days (TG × 1990 – 21F, TG × 1987 – 62F, TG × 1990 – 40F) and five late maturing varieties with maturity dates ranging between 115 – 130 days (TG × 1990 - 106FM, TG × 1989 – 45F, TG × 1448-2E) were used for the study. All of these varieties were sourced from International Institute of Tropical Agriculture, Ibadan (I.I.T.A).

2.3 Experimental Design

The experiment was laid out in a Randomized Complete Block Design (RCBD). (Gerald, 2012). The varieties were planted in three blocks and the treatments were the twelve different varieties. It was arranged such that each block had a different arrangement of treatments. This was to ensure no bias and to check the performance of varieties on different blocks (Gerald, 2012).

2.4 Site preparation

The land was prepared by manual tillage to ensure good germination and reduce weed infestation NPK 15:15:15 was incorporated into the soil at preparation. The spacing used was 50cm between rows and 10cm between stands. The plot size was 2.5m × 1.5m. Thinning was done two weeks after sowing to one plant per hill. At two weeks weeding was done manually and it was repeated at six weeks. At flowering a single spray of Cypermethrin + Dimethoate 10EC at the rate of 100ml in 15 liters of water was used the spraying was repeated after two weeks.

2.5 Data collection

Data was collected for the following characters.

1. **Days to 50% emergence**: The number of days from sowing to when half of the plant in each plot emerged was collected for all the plots studied in accordance with method adopted by Dashiel, 1993.

2. **Days to 50% flowering**: Number of days between sowing and 50% flowering was taken for the samples studied in accordance with method adopted by Dashiel, 1993.

3. **Plant height (cm)**: Average height of three plants measured from the ground to the point of attachment of the upper most (flag) leaf in centimeters was taken on a weekly basis until the plants attained 50% flowering. This measurement was taken for all the plot studied in accordance with method adopted by Dashiel and Osho, 1998

4. **Number of leaves**: Average number of leaves per plant in each plot was recorded on a weekly basis until the plants attained 50% flowering this was done by manual counting in accordance with method adopted by Dashiel and Osho, 1998

5. **Stem Diameter (cm)**: Thickness of the stem of three plants was measured with a tape the average was obtained and recorded this exercise was done on a weekly basis for each of the plots until 50% flowering was reached for the plants in accordance with method adopted by Dashiel and Osho, 1998

6. **Yield (g)**: The total weight for all the pods at maturity for each plot was taken using a weighing balance in accordance with method adopted by Dashiel and Osho, 1998

7. **Seed weight (g):** The total seed weight was taken per plot this was done in the following process according to the process adopted by Dashiel and Osho, 1998.

8. **Number of flowers**: three plants on each plot was selected and manually counted the average number of the flowers for each plot was then recorded.

9. **Leaf Area (cm^2)**: The process for determining leaf area was done in accordance to the method used by Dashiel and Osho, 1998.

To calculate for each leaf the formula used was:

λ_1 = length of leaf x breadth of leaf / Area of drawn leaf on graph sheet

Where $\lambda_1$is the calculated area for leaf 1

(vii) The average of all the calculated areas were obtained to get the leaf area index.

(viii)The leaf area index is the constant factor used to get the leaf areas.

(viii)The length and breadth previously recorded for each leaf was then multiplied by the leaf area index to get the correct leaf area for all the plots.

Length of leaf (cm) x Breadth of leaf (cm) x Leaf area index = Leaf area (cm^2)

2.5.2 Determination and measurement of oil content

The oil content in milliliters per 100 gram of seed was taken in accordance with the method by Kettle, 2013.

The principle: The fat (oil) was extracted with ether (petroleum either was used instead of ether because of risk of explosion). The solution was distilled and the ether extract was derived and weighed in accordance with the method of Kettle, 2013.

2.6 Statistical analysis

The data collected was subjected to statistical analysis with the help of various standard statistical procedures.

2.7 Analysis of variance (ANOVA)

Analysis of Variance was conducted using the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) version 9.0 Software to test pre-harvest and post-harvest traits. Duncan's multiple range test (DMRT) was used to separate the means of all yield parameters studied where significant differences exist.

The standard linear model for an RCBD is as follows:

$$y_{ij} = \mu + \alpha_i + \beta_j + e_{ij}$$
$$i = 1........a,\ j = 1........b$$

Where: y_{ij} = An observation in treatment i and block j

μ = The overall mean

α_i = The effect of treatment i

β_j = The effect of block j

ℓ_{ij} = Random error with mean 0 and variance σ^2

a = The number of treatments;

b = the number of blocks

2.8 Correlations

Correlation coefficients was worked out to determine the degree of association of characters with yield and also among the yield components, using statistical analysis system(SAS) programmer.

2.9 Estimate of correlations

Correlation coefficients were estimated using the Pearson correlation coefficient formula given by Singh and Chaudhary, (1985), Bozokalfa*et al* (2010)

$$r_{xy} = \frac{\text{cov}(xy)}{\sqrt{\text{var}(y)}\ \text{var}(x)}$$

Where: $\text{cov}(xy) =$ covariance of trait x and y

Var(y) =variance of y

Var(x) = variance of x

Among the six varieties studied, significant differences was observed for plant height, leaf area and stem diameter, except number of leaves among varieties. Significant differences (P <0.05) was also observed for pods weight per plot, 100 seed weight , number of seeds per pods and total number of pods per variety.This is so in this study as the different genetic properties of the varieties can be said to be responsible for the significant differences in all the parameters studied.

Ali *et al*. (2006) had a similar result when experimenting with different genotypes of soybean they reported that analysis of variance and mean performance for yield and its components revealed significant differences among all the genotypes for all the characters studied. These results were also in conformity with that of Khanghah*and Sohani* (which showed significant differences for days to maturity, plant height and seed yield.

III. RESULTS

3.1 Analysis of Variance for early maturing soybean varieties

Analysis of Variance was conducted for yield traits (plant height, leaf area, stem diameter number of pods,number of leaves, seed weight, weight of seeds without pods, grain yield number of seeds per pod, oil content) in 8 weeks for the seven varieties. The result (Table 3.1) showed the following results.

Table 3.1 Analysis of Variance for early maturing soybean varieties

Source	DF	NL	SD	LA	PH	NP	WT	WWT	NSP	Grain yield	OIL CONTENT
gen	6	90.603	0.190	5.670	4040.193**	18019.937**	0.857**	0.237**	3.429**	12876.432**	164.034**
rep	2	363.738	0.081	19.799	34.445	4162.667	20.621	6.047	0.381	330.321	1.977

No significant difference was observed for number of leaves, stem diameter and leaf area across varieties. (Table 3.1). Highly significant differences were observed in plant height (4040.19cm),between earlyvarieties of soybean observed at (P <0.05) (Table 3.1).

There was high significant difference between number of podsacross varieties (18019.93) at (P <0.05). Significant differences were observedfor seed weight (0.857cm) and weight without pods at (P <0.05) (Table 3.1).Highly significant difference was observed inoil content for the seven varieties (164.034) at (P <0.05).

3.2. Analysis of Variance for some late maturing soybean varieties

Analysis of Variance was conducted for yield traits (plant height, leaf area, stem diameter number of pods,number of leaves, seed weight, weight of seeds without pods, grain yield, number of seeds per pod, oil content) in 8 weeks for the seven early maturing varieties. The result (Table 3.2) showed the following results.

Table 3.2. Analysis of Variance for late maturing soybean varieties

Source	DF	NL	SD	LA	PH	NP	WT	WWT	NSP	Grain yield	OIL CONENT
gen	4	3355.758	2612.614**	45.663*	574.760	12866.133**	14.844**	0.439**	5.333**	100344.88**	488.020**
rep	2	5756.275	7052.730	36.545	17046.110	330.533	5.239	0.035	0.533	450.643	0.078

No significant difference was observed for number of leaves andplant height varieties. (Table 3.2). Highly significant differences were observed in stem diameter, number of pods, seed weight, weight without pods and number of seeds in pods between latevarieties of soybean at (P <0.05) (Table 3.2).Also highlysignificant difference was observed foroil content across varieties (488.020) at (P <0.05).

Table 3.3 Correlation between oil content and yield parameters forsome early varieties

	OIL CONTENT	NSP	WWT	WT	NP	Grain yield
OIL CONTENT	1	-0.8317	-0.06329	-0.15336	0.36549	0.215**
NSP	-0.8317	1	-0.02207	-0.02993	-0.36055	0.459*
WWT	-0.06329	-0.022	1	0.91206	0.28266	0.462*
WT	-0.15336	-0.02993	-0.91206	1	0.31505	0.465*
NP	0.36549	-0.36055	0.28266	0.31505	1	0.552**
Grain yield	0.215	0.459	0.462	0.465	0.552	1

Correlation between oil content and yield traits for some early maturing varieties of soybeans

Correlation between weight with pods, weight without pods (r= 0.912) and number of pods(r= 0.315) was highly significant, but was not significant with number of seed per pod (r= -0.029) and oil content (r= 0.570)

Correlation between weight without pod, number of pods (r= 0.282) and weight with pods(r= 0.912) was highly significant. While oil content and number of seed per pods were not significant (r= -0.022).

Correlation between number of seed per pod, number of pod (r= -0.360) and oil content was highly significant (r= -0.832), while there was no significant difference between number of seed per pod and weight with pod (r= -0.029) and weight without pod (-0.022).

Correlation between number of pod with weight with pod (r=0.3150) and number of seed per pod (r= -0.360) and oil content (r= 0.365) was highly significant.

Correlation between grain yield, oil content(r= 0.215) and number of seed per pod (r= 0.459) was highly significant, while there was significant difference between grain yield, number of pods (0.552), weight with pod(r= 0.466) and weight without pod(r= 0.462).

Table 3.4 Correlation between oil content and yield parameters for some late varieties

	OIL CONTENT	NSP	WWT	WT	NP	Grain yield
OIL CONTENT	1	-0.59481	0.64714	0.02175	0.26273	0.1874**
NSP	-0.59481	1	-0.42406	0.02472	-0.61495	0.8432*

WWT	0.64714	0.42603	1	0.19294	0.42603	0.6291*
WT	0.02175	0.56993	0.19294	1	0.56993	0.5102**
NP	0.26273	-0.61495	0.42603	0.56993	1	0.3362**
Grain yield	0.1874**	0.8432*	0.6291*	0.5102**	0.3362**	1

Correlation between oil content and yield traits for some late maturing varieties of soybeans

Correlation between weight with pods, and number of pods was highly significant (r= 0.569), but was not significant with number of seed per pod (r=0.569), oil content (r=0.022) weight without pod (r=.0.193)

Correlation between weight without pod, number of pods (r=0.42603) and oil content(r= 0.647) was highly significant. While weight with pods (r=0.193) and number of seed per pods were not significant (r=0.426).

Correlation between number of seed per pod, number of pod (r= -0.615) and oil content (r= -0.59) was highly significant, while there was no significant difference for weight with pod (r= 0.025)

Correlation between oil content, weight without pod (r=0.65) and number of seed per pod (r= -0.59) was highly significant, while there was no significant difference for number of pod (r=0.26)and weight with pod (0.022).

Correlation between grain yield, oil content (0.8174), weight without pods (0.510) and number of seed per pods (0.336) was highly significant, while there was significant difference between grain yield, number of pods (0.843) and weight with pods (0.629) was significant

IV. RESULT AND DISCUSSION

Varieties of testing were very important so we could evaluate which varieties were the best solutions for the specific growing region (Djekic*et al*., 2013). Adequate choice of soybean cultivar is of great importance for attaining high and stable yields to meet and surpass local needs.

Among the six early varieties studied, No significant difference was observed for number of leaves and plant height. (Table 3.2), indicating that there is no genetic variation for those traits. Highly significant differences were observed for stem diameter, number of pods, seed weight, weight without pods and number of seeds in pods between late varieties of soybean at (P <0.05) (Table 3.2). This indicates the existence of considerable amount of genetic variation among the traits. Also highly significant difference was observed for oil content across varieties (488.020) at (P <0.05), indicating the existence of genetic variability among varieties.

Ali *et al*. (2006) had a similar result when experimenting with different genotypes of soybean they reported that analysis of variance and mean performance for yield and its components revealed significant differences among all the genotypes for all the characters studied. These results were also in conformity with that of Khanghahand Sohani (1999) which showed significant differences for days to maturity, plant height and seed yield.

The positive correlation between all these parameters studied shows that an increase in each trait will also lead to an increase in the other trait it is correlated to that is if all required conditionsfor proper growth and environment are met. This findings was in line with that of Moradi and Salimi (2012) who observed significant variations in all the parameters studied and showed significantly positive correlation of plant height, pods per plant, dry matter, and branches per plant with grain yield.

Since all the varieties studied have been exposed to the same ecological and environmental factors they all showed the same positive significant correlation in spite of varying genetic components. Ali *et al*. (2003) reported interrelationships between yield and its components in different soybean genotypes and reported that seed yield per plant was positively and significantly associated with all parameters studied which is same as observed in this work. They reported that pods per plant has maximum positive direct effect on yield per plant followed by 100 seed weight and pods per plant, seeds per pod and 100 seed weight were the main yield components.

Leaf area showed a positive correlation with oil content and significant correlation with grain yield. This findings was in line with that of Ashraf *et al*. (2012) who reported significant and positive correlation of leaf area with pods per plant and oil content he suggested that the characters can be considered as selection criteria in improving the bean yield of soybean genotypes. Therefore from the obtained results varieties with larger amounts of grain yield would produce higher oil content. This can be explained that higher quantities of soybean would produce more oil. Similarly Rezaiand Siahsar(1999) also reported that the number of pod per plant had the greatest genotypic correlation with seed yield in soybean which is similar with results obtained from this study Jagdish*et al*. (2000)

reported that improvement can be done on the basis of pods per plant, 100 seed weight and seed quality. Ashraf *et al*. (2012) also lends support to this result as he reported that correlation coefficient of yield was significant and positive with leaf area, pods per plant and oil content. In soybean, seed yield, as in other crops, is a complex character, which is dependent on a number of variables. Thus, to make effective selection for high seed yield a thorough understanding of yield contributing characters and their interrelationships among themselves and with yield is necessary. Therefore, knowledge of relationship between yield and its components obtainable through correlation and regression analysis helps a great deal to formulate selection. Correlation coefficient (r), measures the degree (intensity) and nature (direction) of association between characters (Moradi and Salimi 2012).

V. DISCUSSION

Correlation between oil content and yield traits for some early maturing varieties of soybeans

A positive significant correlation between desirable traits is favorable because it helps in simultaneous improvement of both the characters. Negative correlation will hinder the simultaneous expression of both.

Weight with pods correlated positively with weight without pods and number of pods. While there was no correlation between weights with pods, number of seed per pod and oil content.

Weight without pod correlated positively with number of pods and weight with pods, while there is no correlation between weight with pod and oil content and number of seed per pods.

Number of seed per pod correlated positively with, number of pod and oil content, while there was no correlation between seed per pod, weight with pod and weight without pod.

Number of pod correlated positively with, weight with pods and oil content, while there was negative correlation between number of pod and number of seed per pod.

Grain yield correlated positively with, number of seeds per pods, number of pods, weight without pods, weight with pods, oil content, this result is in corroboration with the findings of Rajanna*et al*., (2000) who estimated significant and positive correlation of number of pods per plant, with grain yield and the findings of Chamundeswori and Aher (2003) for grain yield showed positive correlation with number of pods per plant.In such situation some economic compromise has to be made.This indicated that simultaneous selection for these traits might bring an improvement in seed yield.

VI. CONCLUSION

The results obtained in the present investigation clearly indicated that improvements in seed yield are simultaneously possible through indirect selection for number of pod per plant which is highly correlated with seed yield.

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