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Path Coefficient Analysis in Ethiopian Noug (*Guizotia abyssinica* Cass.)

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Abstract

Noug (Guizotia abyssinica (L.f.) Cass., 2n=30), a member of the Compositae family is grown as an oil seed crop in Ethiopia. The crop grows best on poorly drained heavy clay soils. Successful breeding of G. abyssinica Cass. for high seed yield and oil content requires knowledge about the traits that influence seed yield and oil content directly and indirectly. This study was undertaken to examine the interrelationships for several agronomic traits to find out the major direct and indirect contributors to seed yield and oil content through path coefficient analyses. Eighty-one noug accessions were grown at Adet, Ethiopia. Path coefficient analyses revealed that capitula per plant and 1000 seed weight had highest positive direct effect on seed yield per plant. Thousand seed weight had highest positive direct effects on oil content. To improve seed yield breeders should concentrate on capitula per plant, and 1000 seed weight. On the other hand, to improve oil content, 1000 seed weight and seeds per capitulum had positive direct effects on oil content.

Key words: **Ethiopia, germplasm, *Guizotia abyssinica Cass.*, oilseed, path analysis**

INTRODUCTION

The genus *Guizotia* Cass., Compositae, comprises six species. Five of these species occur in Ethiopia, where the genus probably has its centre of origin, or at least, centre of present diversity (Baagoe, 1974). Noug (*G. abyssinica* (L.f) Cass; 2n=30

(European name "Niger") is believed to have been domesticated in Ethiopia (Darlington, 1973) probably from *G. scabra* (Vis.) Chiov. *ssp.* Schimperi (Sch.) Baag., which is native to Ethiopian highland (Baagoe, 1974). This was recently supported by Hieremath and Murthy (1988) who used phytogeographic, morphological and cytological evidences.

Noug is extensively cultivated in Ethiopia and India. It is also found in some areas of Sudan, Uganda, Zaire, Tanzania, Malawi, Zimbabwe, the West Indies, Nepal, Bangladesh, and Bhutan (Weiss, 1983). Noug is cultivated mainly for its high-quality edible oil amounting to 30-50% of seed weight (Seegler, 1983). It contributes about 50-60% of the Ethiopia's edible oil needs (Riley and Hiruy, 1989). In addition, it has high protein content and is semi-tolerant to salinity and performs well under poorly aerated soil conditions (Abebe, 1975).

Noug is grown at an altitude of 1500-2400 m above sea level, in rotation with cereals on poorly drained soils. Fertilizer and drainage promotes luxurious vegetative growth but do not increase seed yield. There are fewer diseases and insect pests recorded on noug.

Noug seed yields pale yellow oil with a pleasant nutty taste. The seed contains about 40% oil with a fatty acid composition of 75-80% linoleic acid (Getinet and Tekelwold, 1995), thus being important in preventing arteriosclerosis in human (Vaughan, 1970). The oil is also used as illuminant, as lubricant, for soap manufacturing and for paints (Simmonds, 1976), it also has potential for cosmetics manufacturing (Vaughan, 1970).

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Noug is the top ranked oil crop both in terms of area and production in Ethiopia (CSA, 1997); however, the yield per unit area is very low compared to other oil crops. To breed noug for high seed yield and oil content, it is desirable to know the traits that influence seed yield and oil content directly and indirectly. Limited studies have been reported that describes phenotypic variability and simple correlations between seed yield and oil content and a number of agronomic traits (Genet, 1994; Adhanom, 1988, 1985). The information on the relative importance of direct and indirect effects of component traits on seed yield and oil content is not available on the Ethiopian lines of noug.

Path coefficient analyses provide more information between variables than do simple correlations (Dewey and Lu, 1959; Bhatt, 1973; Kang *et al.*, 1983), because they not only show relationships between predictor and response variables (direct effects of specific yield components on yield), but also show interrelationships between the predictor variables in their effects on the response variable (indirect effects of specific yield components on response variables via other yield components). Hence, path coefficient analysis was conducted to find out the direct and indirect contributors of component traits on seed yield and oil content.

MATERIAL AND METHODS

The study was conducted in northwestern Ethiopia at Adet Research Centre (longitude 37° 29' E; latitude 11° 16' N, 2240 meters above sea level) in 1997 main cropping season (keremet). Seventy-nine, noug accessions that had randomly sampled from varied eco-geographical regions of the country and two standard checks (Este-1 and

Fogra-1) were used. Forty seeds of each accession were space planted on vertisols in a single row of 4 m length plot, with a spacing of 1 m between rows and 10 cm between plants arranged in a 9x9 triple lattice design. Recommended cultural practice was followed to maintain uniform crop. Fertiliser (both N and P_2O_5) was applied at the rate of 23 $Kgha^{-1}$ each at the time of planting. Weeding was carried out 21 days after emergence and 45 days after the first weeding.

Observations on quantitative characters (days to flowering, plant height, leaf length, number of leaves per plant, primary branches per plant, nodes per plant, number of capitula per plant, seeds per capitulum, 1000 seed weight, seed yield per plant and oil content) were also recorded on ten plants per accession following the noug description format of the Biodiversity Conservation and Research Institute of Ethiopia. Days to flowering is the actual count of the number of days from planting to the date at which about 50% of the plants in the plot have the first flower. Plant height is the actual measurement in cm taken from the ground to upper most leaf at 50% of flowering. Leaf length is the actual measurement taken in cm of the leaf subtending the fourth node at 10% of flowering. Leaf number is the actual count of the number of leaves per plant at 50% flowering. Number of nodes per plat is the actual count of the number of nodes per plant at 50% flowering. Number of primary branches is the actual count of the number of branches on the main stem at 50% flowering. Number of capitula per plant is the actual count of the number of capirula per plant. Seeds per capitulum are the actual count of total seeds per capitulum, on average of five capitula per plant. Thousand seed weight is the actual measurement of the 1000 seeds in grams using seed counter. Seed yield per plant is the weight of seeds in grams per plant. Oil content is the percentage of oil content of the samples determined by wide line Nuclear Magnetic Resonance (NMR) Spectrometer.

In order to compare the relative importance of the yield components in predicting seed yield and oil content, path coefficient analysis was made as suggested by Dewey and

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Lu, 1959). Only those components, which showed significant positive associations with seed yield and oil content with the component traits, were included for this analysis.

RESULTS AND DISCUSSION

Seed yield

Days to flowering, leaf length, number of leaves per plant, primary branch per plant, number of capitula per plant and 1000 seed weight were considered as casual variables for seed yield per plant (Table 1). Path coefficient analysis showed that the number of capitula per plant had the highest positive direct effect (0.3781) on seed yield per plant (Table 1). Similar results were reported by Abraham and Gupta (1989) on Indian lines of niger. This direct effect was larger in magnitude than the total correlation (0.366) between number of capitula per plant and seed yield per plant. However, this direct effect was reduced by the moderately low negative indirect influence on the number of capitula on seed yield via number of leaves per plant (-0.0403) and primary branches per plant (–0.0065).

Thousand seed weight had the second major direct contribution (0.1282) to seed yield per plant. This is in agreement with the findings of Singh and Patra (1989) on Indian lines of niger. Effect of number of leaves per plant on seed yield per plant was low and negative (-0.0555). A strong positive influence on seed yield per plant was registered indirectly by number of leaves per plant through number of capitula per plant (0.2745).

Primary branches per plant had negative direct effect on seed yield per plant (-0.0163). Its high correlation with seed yield per plant was due to its positive indirect

effect via number of capitula per plant (0.1516). The indirect effect of primary branches per plant on seed yield per plant via leaf length was relatively moderate (0.0203). Primary branches per plant had very low positive indirect effect on seed yield per plant via days to flowering (0.0094) and 1000 seed weight (0.0098).

The result indicated that all indirect effects of component traits on seed yield per plant via number of capitula per plant had the highest positive indirect effects. On the other hand, all components had negative indirect effects on seed yield per plant via number of leaves per plant and primary branches. This is so because there will be insufficient translocation on partitioning of nutrients between the principal sources and the sink.

Oil content

Days to flowering, plant height, leaf length, number of nodes per plant, number of seeds per capitulum and 1000 seed weight were considered as characters that contribute most to oil content (Table 2)

The direct effect (0.3952) of 1000 seed weight on oil content was found to be positive and very high. The highest positive total correlation (0.439) between 1000 seed weight and oil content entirely resulted from the direct positive effect of 1000 seed weight on oil content. From this we can say that seeds with large embryo (weight) had higher oil content. This is in agreement the finding of Getinet and Belayneh (1989), where seeds with large embryo had higher oil content. Its indirect effect on oil content through leaf length (0.0187) and seeds per capitulum (0.0151) were observed to be very low. The indirect effect of 1000 seed weight via number of nodes per plant was

found to be negligible (0.0079). The indirect effect of 1000 seed weight on oil content via days to flowering was also observed to be very low and negligible (-0.0107).

Days to flowering had negative direct effect (-0.0280) on oil content. Its indirect effect through 1000 seed weight on oil content resulted in the highest total correlation (0.221) between days to flowering and oil content. All the other indirect effects via plant height (0.0225), leaf length (0.0291), number of nodes per plant (0.0203) and number of seeds per capitulum (0.0203) were observed to be positive and relatively low.

Plant height had low and positive direct effect (0.0351) on oil content. The indirect effect of plant height on oil content via 1000 seed weight (0.1419) was positive and very high, which contributed to the total correlation (0.225). The indirect effects of plant height on oil content through leaf length, nodes per plant and seeds per capitulum were positive. The indirect effect of plant height on oil content via days to flowering was negative.

The direct effect of leaf length (0.0711) on oil content was positive. Its indirect effects on oil contents via plant height, nodes per plant, seeds per capitulum and 1000 seed weight were positive. The indirect effect of leaf length on oil content via days to flowering was negative.

Comparatively, number of seeds per capitulum had high positive direct effect (0.0814) on oil content. Its indirect effects on oil content via plant height, leaf length, nodes per plant, and 1000 seed weight were positive whereas the indirect effect of number of seeds per capitulum was negative.

The direct and indirect effect, of all components on oil content via days to flowering was negative. On the other hand, indirect effect of all components on oil content via 1000 seed weight was positive and very high.

In general path analyses showed that capitula per plant and 1000 seed weight had the highest positive direct effect on seed yield per plant. To improve seed yield breeders should concentrate on capitula per plant, and 1000 seed weight. On the other hand, to improve oil content 1000 seed weight and seeds per capitulum had positive direct effects on oil content. So selection among germplasm based on capitula per plant, seeds per capitulum, and 1000 seed weight should improve production level of noug.

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Table 1. Direct effect (bold) and indirect effect of component traits on seed yield/plant, Adet, Ethiopia, 1993.

No	Characters	1	2	3	4	5	6	Correlation With seed yield
1	Days flowering	**0.0357**	0.0379	-0.0159	-0.0042	0.0983	0.0492	0.201**
2	Leaf length	0.0146	**0.0925**	-0.0189	-0.0036	0.0536	0.0337	0.180**
3	Number of leaves/plant	0.0102	0.0184	**-0.0555**	-0.0055	0.2745	0.0169	0.259**
4	Primary branches/plant	0.0094	0.0203	-0.0189	**-0.0163**	0.1516	0.0098	0.156**
5	Capitula/plant	0.0092	0.0131	-0.0403	-0.0065	**0.3781**	0.0123	0.366**
6	1000 seed weight	0.0137	0.0243	-0.0073	-0.0012	0.0362	**0.1282**	0.194**

**: Highly significant at 1% probability level.

Table 2. Direct effect (bold) and indirect effect of component traits on Oil content, Adet, Ethiopia, 1993.

No	Characters	1	2	3	4	5	6	Correlation With oil content
1	Days flowering	**-0.0280**	0.0225	0.0291	0.0203	0.0250	0.1517	0.221**
2	Plant height	-0.0180	**0.0351**	0.0343	0.0149	0.0167	0.1419	0.225**
3	Leaf length	-0.0114	0.0169	**0.0711**	0.0073	0.0190	0.1039	0.207**
4	Nodes/plant	-0.0157	0.0145	0.0144	**0.0361**	0.0152	0.0873	0.152*
5	Seeds/capitulum	-0.0086	0.0071	0.0166	0.0067	**0.0814**	0.0735	0.177*
6	1000 seed weight	-0.0107	0.0216	0.0187	0.0079	0.0151	**0.3952**	0.439**

*, **: Significant and highly significant at 5% and 1% probability level respectively.