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Cultivation of niger seeds –a treasure plant to secure availability of edible oil in Ethiopia

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Abstract

The availability of edible oil in Ethiopia is limited typical plants as rape or sun flower are not cultivated. Niger Seed (*Guizotia abyssinica* Cass.) is native to Ethiopia and has a very good quality for edible oil, but underestimated in this regard and exported as birdfeed in industrial countries. In northern Ethiopia as in the highland area of Amhara Region nigerseed was cultivated long time by small holder farmers. The aim of this study was to identify land with favourable soil and climate conditions and sufficient water availability for nigerseed cultivation, as well convenient transportation to oil mills. In the fielde xperiments were investigated cultivation methods using the cultivars Fogera and Kuyu, different nitrogen fertilisation in their effect on seed yield, seed quality and postharvest handling, as well as the oil expression efficiency and the quality parameters for nigerseed. The field experiments were prepared in a randomised block for statistical analyses with three repetitions. Based on field study in the locations, Adet and Koga, three seed rates and three fertiliser rates the highest mean nigerseed yield was 1384.6 kg ha^{-1} at Adet location (rainfed) followed by location Koga (rainfed) with 1064.7 kg ha^{-1} and Koga (irrigation) with 967.0 kg ha^{-1} showing significant difference. The seeds were stored in the laboratory for four weeks before the analysis started. Before further laboratory analysis started was ascertained the seed yield (kg ha^{-1}), moisture content (%) (Dry basis), thousand seed mass (gram), and total ash content (%). Oil content determination was done for all the three cultivations for comparison i.e. Adet (rainfed), Koga (rainfed), and Koga (irrigation). Fatty acid and vitamin E determination was only done for the Adet experimental station (rainfed). The oil content by experimental location was 41.54% for Koga (rainfed) followed by 39.59 and 38.67% for Koga (irrigation) and Adet (rainfed) respectively showing significant difference whereas the Ash content showed a reverse trend of oil content. Fatty acid composition did not show significant difference in any treatment. Significant mean α-tocopherol of 80 mg/100 g (70 to 89 mg/100 g) was determined for increasing seed and nitrogen rates.

Keywords: Cultivation conditions of nigerseed, cultivation irrigated and non-irrigated, oil content, seed quality, seed yield, α-tocopherol and oil expression

1. Introduction

The Ethiopian edible oil industry suffered serious challenge mainly as a result of oilseed shortage and this made the country heavily import dependent for edible oil. Ethiopia is currently

dependent on imported edible oil mainly from Asia, for about 80% of its consumption (Wijnands et al., 2009). Import of edible oil, mainly palm and soybean, is increasing rapidly and progressively displacing the local edible oils like Niger seed and linseed oils. Niger Seed (Guizotia abyssinica Cass.) is native to Ethiopia and has a very good quality for edible oil, but underestimated in this regard and exported as birdfeed in industrial countries.

Surveys indicate that many oil mills in Ethiopia are working under capacity for most of their time (Schenk et al., 2009). According to this survey the mills are operational only for 20-30% of their potential. This under capacity working of the oil mills in Ethiopia is mainly due to shortage of raw material/oilseeds (Schenk et al., 2009; Wijnands et al., 2009). When available the oilseeds are expensive which makes the oil pressed from them less competitive than the imported cheaper ones. Both availability and price of the oilseed are fundamental challenges in Ethiopia (Lefebvre, 2012). As a solution to this pressing problem Niger seed and linseed were selected among the oilseed for edible oil value chain enhancement in Ethiopia (Lefebvre, 2012). Although seed supply problem could be further subdivided into many the major problem is its low seed and oil yield (production per hectare). Therefore to make Niger seed more competitive in the market and make a priority crop, agronomic optimization could be one among arrays of alternatives approaches to solution. Agronomic optimization is of obvious need for any crop plant cultivation to select the necessary condition and apply the necessary inputs in an efficient and sustainable way so that full potential of the crop is expressed and the maximum possible yield is obtained. In northern Ethiopia as in the highland area of Amhara Region Niger Seed was cultivated long time by small holder farmers. This seeds are also economically important for small scale edible oil millers in Ethiopia. However the Niger seed yield, postharvest handling, and the efficiency of oil expression are the major bottle necks in the competitiveness of the seed/oil in the market. Therefore, the aim of this study was to investigate circumstances and factors influencing the seed yield, oil content, oil quality and seed quality under different storage conditions as well as the oil expression efficiency.

2. Material and methods

Two independent groups of experiments and investigations were necessary to answer these questions: field cultivation and efficiency of pressing virgin oil.

The first set of experiment encompasses three field experiments under different agronomic treatments and two varieties in two Northern Ethiopian highland regions (Adet and Koga) in 2010 and 2011 during both dry and rainy seasons. The treatment variables were two varieties (Fogera and Kuyu), seed rate (5, 10, 15 kg ha^{-1}), nitrogen fertilizer rates (13, 23, 33 kg ha^{-1}). Additionally the influence of season on the yield and seed quality was compared. The experimental field in Adet was rain fed whereas that of Koga was both rain fed and irrigation comparison. In the three field experiments effect of the treatments on the yield (seed and oil) as well as the quality compositions (fatty acid and α-tocopherol) were evaluated.

3. Results and discussion

Phenotypic responses, seed yield, seed oil content, oil fatty acid and vitamin E profile, and seed ash content were the data taken from the field experiment. Some of these responses were taken from both experimental locations one of which (Koga location) has two water supply modes (rain fed and irrigation) and the other one (Adet location) has one water supply mode (rain fed) From the field experiment the phenotypic responses of the two selected Niger seed cultivars (Fogera and Kuyu) were measured phenotypic data, but only taken from Koga location with irrigation cultivation.

Except number heads per plant the phenotypic variation due to the treatments at various levels was found to be non-significant for both varieties (Figure 1).

Number of heads per plant would be of meaningful importance if and only if it has significant contribution to seed yield. It can be seen that the significant difference in number of heads per plant appears to be cumulative of slight and non-significant difference in number of branches per plant and number of heads per branches which made Fogera cultivar significantly higher number of heads per plant. It is also clearly seen that flowering day, maturity period as well as thousand seed mass for the two varieties is almost same. Important was the analysis of the influence of all tested parameters on the seed yield, as the place of cultivation, the cultivars, nitrogen and seed rates and the water supply by

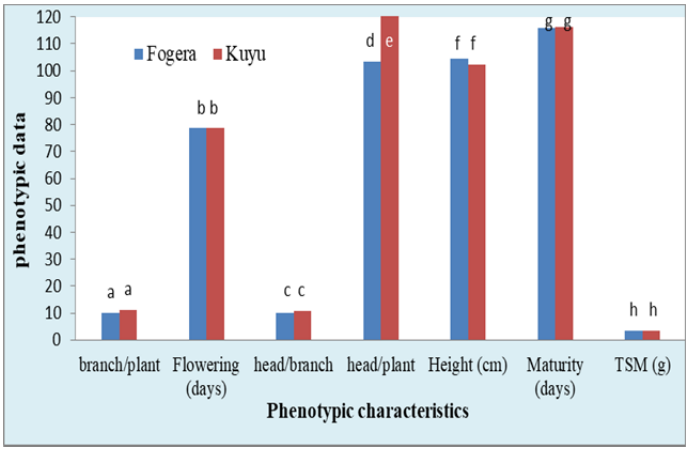

Fig1. Phenotypic characteristics of the cultivars Fogera and Kuyu during cultivation in location Koga with irrigation. (Tukey test, P<0.05) (Melaku, 2013)

natural precipitation (rain fed) or additional irrigation. The seed yield in Adet was the highest by rain fed whereas in Koga by rain fed the seed yield was significantly lower for two dosages of Nitrogen fertilizer it seems further tests are necessary. Analysing the contribution of each factor at different levels and in this case the influence of nitrogen rate of 23 kg ha-1 (Kuyu at Koga by Rain fed) and seed rate of 10 kg ha-1 (both Kuyu and Fogera at Koga by Rain fed) it can be stated this treatments are to be in favour in comparison to the other treatments. Therefore in general the rain fed was in favour to irrigation water supply mode and Adet location was favourable in comparison to Koga. Difference between the two varieties was seen more clearly from cultivation at Adet location (rain fed) where Fogera generally appears to be better than Kuyu. Adet location is again observed to be better than Koga location (Fig.2).

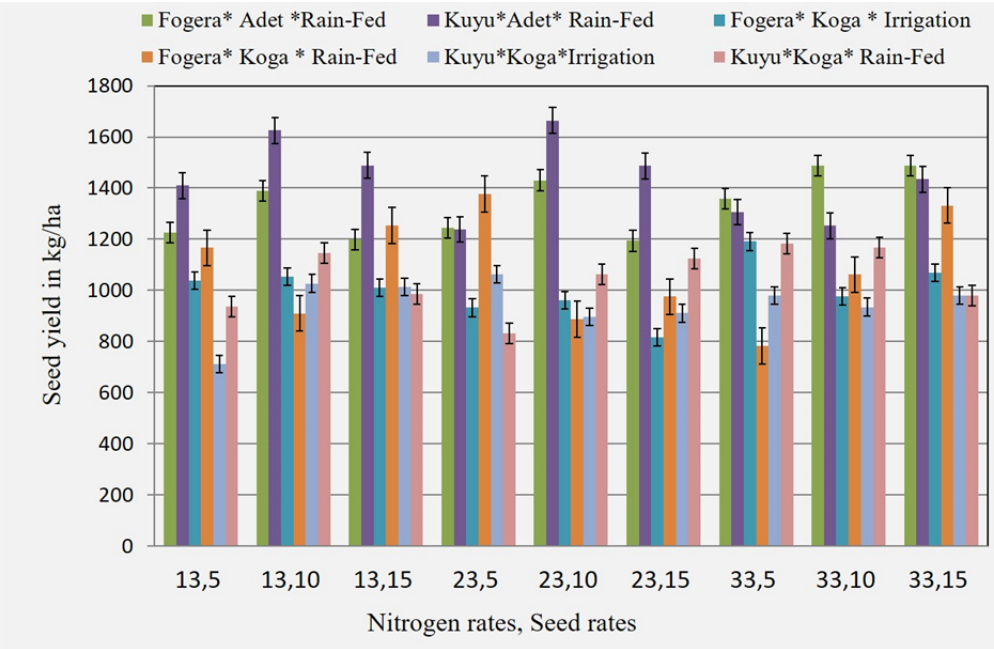

Fig. 2. Seed Yield (kg/ha) of Niger seeds with different Nitrogen and Seed rates on two locations in the Highland of North Ethiopia in the region Adet and Koga (with possibility of irrigation)

The oil content was analyzed for both locations/ the three cultivations (Koga irrigation, Koga rain fed, and Adet rain fed). The comparison by only location/water supply mode shows that there is significant difference (not shown in this figure) between locations Adet and Koga by rain fed as well as between Koga locations by rain fed and irrigation (Fig. 3). On the other hand there is no significant difference between Koga location by irrigation and Adet location by rain fed. Location Koga specially the rain fed appears to be generally better than location Adet in this regard. From the location Koga with rain fed itself Kuyu variety showed better performance than Fogera cultivar.

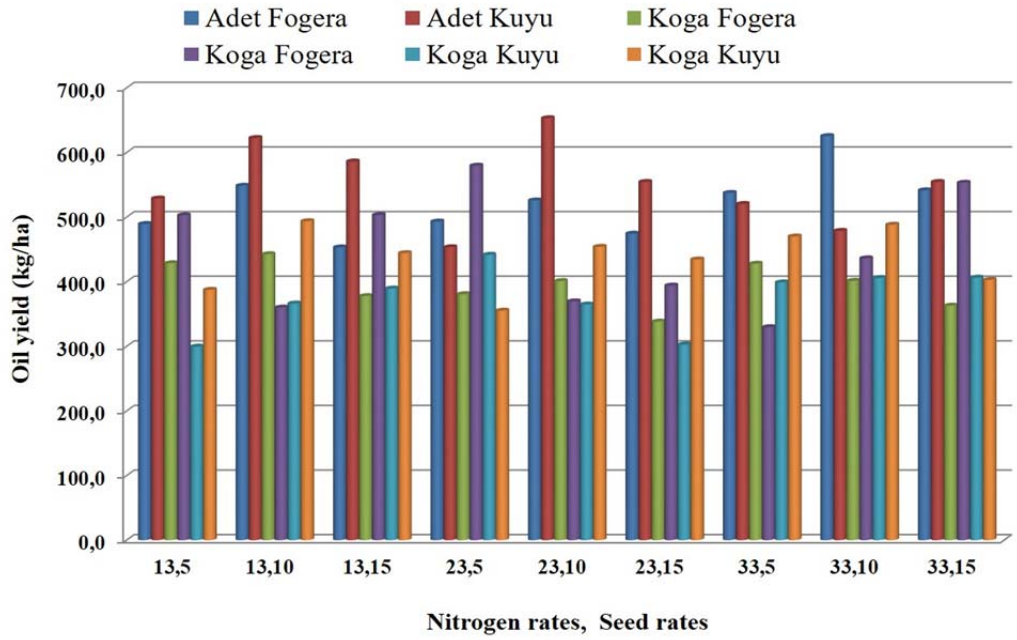

Fig. 3. Oil yield (kg/ha) of Niger seed with different Nitrogen and Seed rates on two locations in the Highland of North Ethiopia

The results also shows that location/water supply is more important than the other treatments (seed rate, nitrogen rate, and variety). Comparison of location/water supply shows that Koga location by rain fed to be the best performer and Adet location by rain fed to be the least performer.

One of the important quality feature is the content of the nigerseed oil is Vitamin E (alpha tocopherol). The observation of vitamin E from high seed and high nitrogen rates is encouraging and has similar trend with some of the fatty acids. It could be noticed that the interaction of seed rate and nitrogen rate depicted significant effect compared to the other interactions (Figure 4).

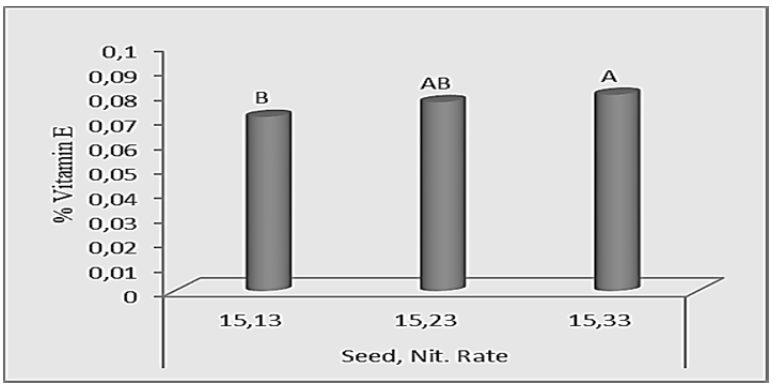

Fig. 4. Influence of the Nitrogen rate (for same Seed rate) on vitamin E (alpha tocopherol) content of Niger seed oil (letters indicate significant difference, Tukey test $P<0.05$). (Melaku 2013)

The maximum mean vitamin E content of 0.08 ranging 0.0698 - 0.0892 mg/100 g was recorded from the interaction of maximum seed rate (15 kg ha^{-1}) and maximum nitrogen rate (33 kg ha^{-1})

Although significant difference is lacking between vitamin E for most of the factors involved and the interactions, it is possible to observe the effect of the factors and their interactions. This interesting observation of positive correlation between seed density and vitamin E content need further investigation as especially the interaction with nitrogen fertilizer is also encouraging.

(Dutta et al., 1994) showed tocopherol analysis of Niger seed samples collected from different regions of Ethiopia to be 0.068-0.085 % (wt. /wt.). α-tocopherol is 90% of the total tocopherol and γ-tocopherol is 3-5%, β-tocopherol was found to be minor in composition of ca. 1%.

4, Conclusion

- The Niger seed yield improvement was possible mainly due to suitable location as the highland area of Amhara Region and the water supply by natural precipitation or irrigation.
- Investigations of the phenotypic differences between the two cultivars Fogera and Kuyu can be neglected.
- The Oil yield was also affected by Location, Water supply, Nitrogen and Seed rates.
- Efficiency of oil expression could be raised by conditioning temperature
- The oil millers in Ethiopia can play their role if institutionalized technology support is provided in addition to oilseed supply.
- It could be realized that either fresh type seed or properly stored seed can be used for virgin oil production
- Vitamin E content was significantly affected by the nitrogen rate

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