Pakistan J. Sci.Ind. Res., Vol. 27, No. 4, August 1984

EXPERIMENTAL CULTIVATION OF *VERNONIA PAUCIFLORA* – A RICH SOURCE OF VERNOLIC ACID

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(Received July 26, 1984)

Various cultivation parameters for the cultivation of *Vernonia pauciflora* (N.O. Compositae), have been studied. This exotic species has been successfully introduced and the crops have been raised in the fields of the PCSIR Laboratories, Lahore, for six successive years with satisfactory results. It has been found that on average the plants mature in 180 days (November-May) and the seeds yield an oil (33-37%) that contains (74-80%) vernolic acid.

INTRODUCTION

The genus Vernonia (Plant family Compositae) comprising of 380 species is abundantly found in Brazil, Madagascar, southern Asia, tropical countries and United States. In Pakistan *Vernonia anthelmintica* is cultivated in plains to 2200 m. and has a reputation as medicinal plant, whereas *Vernonia arborea, Vernonia cinerascens* and *Vernonia cinera* are cultivated as ornamental plants.

Two species of genus *Vernonia* have been identified by Agriculture Research Service, USA, as promising source of vernolic acid. *Vernonia anthelmintica*'s seeds contain 22-28% oils with a high content of vernolic acid (70-75%). In spite of serious efforts suitable varieties of this species could not be developed for large scale cultivation. The main problems with this species are indeterminate flowering, shattering and the difference in the maturation time of seeds. By the time the upper flowers have matured, seeds produced by the lower flowers have been shed resulting in a low yield of seeds. *Vernonia pauciflora,* however seems to have more promise as a new industrial crop for tropical and sub-tropical areas. The species is not only the best source of vernolic acid it has also suitable agronomic potential as most of its seed mature at the same time and retention of the mature seed is quite good. It is reported to bear 40-42% seed oil that contains 73-80% vernolic acid.

The garden species, *Vernonia anthelminatica* and wild growing *Vernonia pauciflora* contain high percentage of vernolic acid (12, 13-epoxy--oleic acid), in their oils, which because of its chemical constitution, finds extensive use in the manufacture of paints protective coatings; plastic formulation and other industrial products. Currently vernolic acids are obtained by chemical modifications of the fats and vegetable oils which increases the cost of the oil 2-3 times. A market survey indicated the necessity for the development of a new crop for vernolic acid. Higher vernolic acid contents of *Vernonia pauciflora* seed oil thus make it a choice source of this industrially important raw material.

In an earlier communication, cultivation of *Silybum marianum* at Lahore, another species of family Compositae as a source of useful oil was described. In continuation of such studies, introduction and experimental cultivation of *Vernonia pauciflora* for obtaining natural epoxy oil, having over 70% epoxy oleic acid (vernolic acid) has now been studied. This publication, therefore, describes various parameters which have been considered for the introduction of *Vernonia pauciflora* as a cultivated oil seed crop.

EXPERIMENTAL

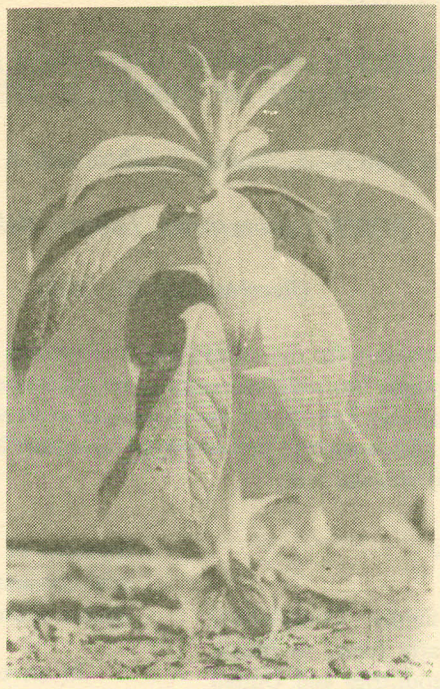
Materials and Methods

1. Seed Sources: The seeds of wild growing *V. pauciflora* were originally collected from Harar, Ethiopia, Harar is located at about 6000 feet elevation 9° 20′ north of Equator with 36 inches means annual rainfall. The other sample was obtained from the plants grown at Kericho, Kenya, which is about 25′ south of the Equator at the elevation of 6500 feet with 72″ mean annual rainfall.

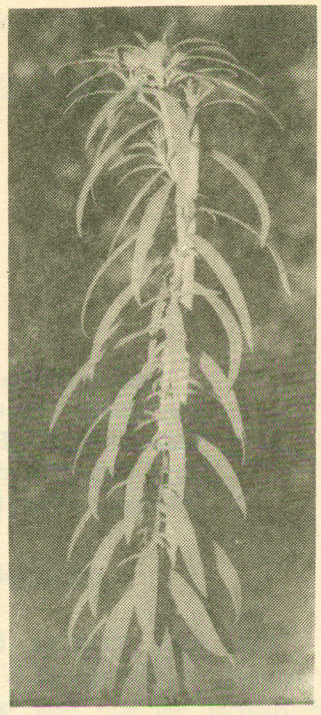
The seeds of *Vernonia pauciflora* were obtained through the courtesy of Dr. D.R. Cronelius of USDA and were grown in Lahore in 1977.

2. Germination and Viability Tests. A specified number of seeds were germinated either on moist blotting paper or in the soil pots. The germination and viability of the imported seeds ranged between 50-75%. The germination percentage, however, later increased to over 90% in the locally harvested seeds (Table 3). It is also observed that seeds lose their viability after about one year when stored at room temperature.

A. 4-week-old seedlings.



B. 8-week-old plants.



C. 12-week-old plant

D. A single capitulum

E. A plant in full bloom

F. Crop before harvesting.

Various stages in development of *Vernonia pauciflora* crop.

3. Cultivation Conditions. The nursery bed was prepared by mixing in clayey soil, canal sand and a suitable quality of farmyard manure in the proportion of 1:1 after the field had been extensively ploughed and levelled. The manure was thoroughly mixed in the soil to a depth of about 20-30 cms. The seeds were then sown by broad-casting in the middle of November (humidity 79% max. 47% minimum; temp. 28°C max., 11°C. min.; rainfall (0.0''). The

nursery beds were immediately irrigated to maintain the moisture. The seeds started germinating after the 3rd or 4th day and the germination was completed on the 7th day. When the seedlings were 30-35 days old with approximately 10-12 centimeter height, they were individually transplanted in the experimental field on parallel furrows of 15-25 centimeters height and 40 centimeters apart.

The plants show normal growth and mature in 180-190 days with few irrigations (3-5 times only). It was further observed that the best mode of plantation was the transplantation of seedlings(1-12 cm height) after raising them in nursery. Though the seeds were sown at various times of year, yet the maximum percentage of germination and viability of plants with better yield of seeds were obtained when sown in the month of November.

The flowering commences in the months of Feb.-March and completed in April. After the terminal flower formation a profusion of lateral branches appeared on the plants and all of them produced flowers, giving the plant a bushy appearance. The fruiting usually starts in April to May and the maturation of seeds is basipetal, that is, the seeds ripen earlier in the heads on lower branches than those on the upper ones. The seeds were harvested from the middle of May. (Humidity max. 62% min. 31%.temp. max. 22°C min. 12 °C. rainfall 0.10) and then thrashed and hand cleaned. The yield of seeds from 2 kanal plot was approximately 56 kg. which comes to 225 kg. per acre. Cultivation trials for six successive years have now indicated that this species can be grown as an important industrial oil crop under local environmental conditions. The data showing eco-meteorological conditions for the cultivation of one crop only is given in Table 1.

4. Estimation of Oil Content. After harvesting the dry clean seeds (1-5 g) were extracted in a Soxhlet with hexane. The extracts were dried and then freed from the solvent under nitrogen atmosphere. The residual light yellow and clear oil was also kept under inert atmosphere. The oil percentage in seeds from different annual crops is given in Table 2.

5. Description of Species. Vernonia pauciflora is a 60-120 centimeter tall annual shrub, leaves alternate, inflorescence capitulum head homogamous. Fruit/seed is an achene consisting of a black hard fibrous hull surrounding a single oblong seed.

DISCUSSION

Suitable cultivation conditions for *Vernonia pauciflora* have been studied. The germination was found to be maximum when the seeds were sown in November. Similarly, through trials, it is established that May was the best month for harvesting as there was no shattering at that time. The seed crop matured in about 180-190 days. The observations on other cultivation conditions are given in Table 3.

The oil yield, as determined experimentally, is slightly

Table 1. Eco-meteorological data of *Vernonia pauciflora*

Sr. No.	Stages	Time	Temperature Min. °C	Temperature Max.°C	Humidity Min.%	Humidity Max.%	Rainfall (inches)	Soil	Irrigation
1.	Sowing	10.11.78	11	28	47	79	0.00	Clayey	Once
2.	Germination	10.11.78	11	28	47	79	0.00	Clayey	Once a month
3.	Flowering	March 1979	12.03	28.03	31	66	0.00	Clayey	Once a month
4.	Fruiting	April 1979	22	36	32	62	0.10	Clayey	Once a month
5.	Harvesting	15.05.1979	24	42	31	62	0.10	Clayey	nil

Table 2. Seed oil percentages of yearwise harvests of *vernonia pauciaflora*

Sr. No.	Harvested in	Source	Oil %age
1.	1977	USDA	40.0
2.	1978	Lahore Labs.	33.0
3.	1979	Lahore Labs.	33.5
4.	1980	Lahore Labs.	37.1
5.	1981	Lahore Labs	36.0
6.	1983	Lahore Labs.	37.0
7.	1984	Lahore Labs	37.0

Table 3. Year-wise observations of cultivation trials of *Vernonia pauciflora* at Lahore.

Sr. No.	Source of seeds	Sowing time	Germination (%)	Flowering period	Harvesting time	Remarks
1	2	3	4	5	6	7
1.	USDA	15.08.1977	75	Feb-April 1978	May, 1978	The rate of growth was slow and 50% of plants died due to excessive irrigation.
2.	Lahore	25.06.1978	50	Dec. Feb. 1979	March-April 1979	The rate of growth was slow and 70% plants survived, at the most five irrigations were given.
3.	Lahore	10.11.1978	80	Feb.-April 1979	April-May 1979	The rate of growth was normal and 70% plants survived. In all five irrigations were given.
4.	Lahore	15.11.1979	90	Feb-April 1980	April-May 1980	The rate of growth was normal and 80% plants survived. In all five irrigations were given.
5.	Lahore	25.09.1980	80	Jan-March 1981	April-May 1981	The rate of growth was normal and 90% plants survived. In all five irrigations were given.
6.	Lahore	08.09.1981	80	–	–	The rate of growth was normal, but due to unexpected rainfalls in February-March 1982 the plants were damaged and those survived showed vigorous and abnormal growth and ultimately died without flowering and fruiting.
7.	Lahore	20.11.1982	90	Feb-April 1983	April-May 1983	The rate of growth was normal and 90% seedlings survived. Only five irrigations were given.
8.	Lahore	15.11.1983	100	Feb–1984	–	The rate of growth was normal and 90% seedling survived. Five irrigations were given to fields.

lower than that obtained either from the wild species of Ethiopia or those cultivated in USA or Kenya. This difference could be due to environmental conditions including soil composition at Lahore. The vernolic acid contents of the cultivated seeds. However, do not vary much from that of the original seeds as given below:

Seed Source	Vernolic acid %
USDA	80
Lahore	74-80

Cultivation studies on *Vernonia pauciflora* thus indicate that the species has a considerable promise to become a new crop for industrial oil. This assumption is based on the observations made for successive six years on germination and cultivation conditions of the species. Presently our study is important not only because *Vernonia pauciflora* is a rich source of oil but also due to the ease with which it has adapted itself to the local environmental conditions.

Furthermore, we have been able to obtain varieties of *Vernonia pauciflora* through selection which attain similar heights, simultaneous flowering and the seeds also mature at the same time. Additionally, there is the advantage that the ripe seeds are not shattered and thus are easy to collect after harvesting.

Further studies on this species are in progress where efforts are directed to select disease resistant varieties with shorter periods of growth and to fit in the cropping pattern in such a way that this oil crop do not compete with the cash crops, thus providing an industrially important oilseed crop in a short period of time. In conclusion, therefore it is pointed out that cultivation parameters for *Vernonia pauciflora* have been established. The species can provide an oil at the minimal cost, that can find extensive applications in the paint industry and other industrial protective coatings due to the presence of vernolic acid in it.

Acknowledgement. Our thanks are due to Dr. M.K. Bhatty, Director, PCSIR Laboratories, Lahore for his constant interest, encouragement and valuable suggestions.

Thanks are also due to Dr. D.R Carnelius of USDA for providing the seed material for the present work.

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