

# Experimental Cultivation of *Dioscorea deltoidea* Wall. at Kuza-Gali, Galies Forest Division.

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## Abstract

*Dioscorea deltoidea* Wall. plant is known for its steroidal sapogenin extracted from rhizomes and is widely used as a precursor for synthesis of various steroidal drugs and sex hormones. In order to develop regeneration technology and its sustained supply, a number of long-term experiments on effect of cultural and fertilizer requirements on growth performance of the plants were under-taken in its natural habitat. Results are presented in this paper.

## Introduction

Steroidal sapogenin extracted from rhizomes of *Dioscorea deltoidea* is the most versatile precursor for the synthesis of steroidal hormones such as pregnenolone, progesterone and cortisone, which plays an important role in curing diseases like arthritis, rheumatism etc. It is also used in oral contraceptive pills. The world production of diosgenin is 500 tons per annum mainly extracted from rhizomes of *Dioscorea* spp. (1) Mexico is the leading producer with 400 tons followed by China and India, contributing 65 tones and 35 tones respectively.

*Dioscorea deltoidea* is a rhizomatous, dioecious climber with un-armed stem twining to the left (2 & 5). The rhizome contains 4-6% sapogenin convertible into 3-4% diosgenin. The plant grows wild in moist and shady localities as under-growth in mixed coniferous forests of North-Western mountainous ranges i. e. Hazara, Swat, Dir, Chitral and Azad Kashmir, at an elevation of 1900 to 2500 m (3 & 4). Some plants are also found on open slopes where sufficient monsoon rain occurs during summer months. The plant is a perennial herb and the rhizomes increase in size gradually and take longer period for maturity. Kurram Chemical Company, Rawalpindi is extracting diosgenin on pilot-scale from the rhizome of *Dioscorea deltoidea* plant. About 80 to 100 tonnes of rhizomes are collected annually for the extraction of diosgenin. Since the plant is uprooted for rhizome extraction, its large-scale and indiscriminate collection if

continued with-out any scientific management may result in its extermination from accessible area of the forests.

To conserve the germplasm as well as to develop regeneration techniques of this species a number of experiments on cultural, agronomical and fertilizer requirements were conducted at Kuza-Gali, which is in moist temperate zone at 2500 m. elevation, with 1650 mm annual rainfall and its natural habitat.

## Materials and Methods

The propagating material, *Dioscorea deltoidea* rhizomes for these investigations was collected from Galiat and Murree Forest areas in the month of June, 1977. The rhizomes were later stored in a mixture of moist soil and fine sand. The following trials were conducted.

### (i). Support provision and fertilizer trials

To determine the effect of support provision and application of different doses of nitrogenous fertilizer on the yield of rhizomes, an experiment was laid out in July, 1977 in split plot design with four replications. Thirtytwo plots measuring 12 m<sup>2</sup> each were prepared and levelled. Rhizomes were dug out from the storage pit in July, 1977 and were cut into pieces of 7 cm length, each with 1 to 2 active buds. Sixty rhizome pieces weighing 1.5 kg were planted in each plot at a spacing of 60 × 30 cm in three rows/plots at a depth of 5 cm on 27th July, 1977. Support of Kana (*Saccharum erianthus*) was provided to the plants after their sprouting for trailing in sixteen plots marked as support treatment; while support was not provided to the plants in the remaining sixteen plots. Four levels of Nitrogen i.e. 0, 100, 150 and 200 kg/ha in the form of urea was applied after sprouting as per design on 15th July, 1978. Weeding and hoeings were carried out in May and August every year and the experiment was continued for six consecutive years. Yield of rhizome was recorded after removing soil and dirt in November, 1983.



## (ii). Spacing studies

In order to find out the effect of various plant spacings on the yield of *D. deltoidea* rhizomes, an experiment was laid down in RCB design with five replications. The experimental area was levelled and divided into 25 plots measuring 8 m<sup>2</sup> each. Rhizomes of *D. deltoidea* were taken out from storage pit and later cut into pieces of 7 cm length having 1 to 2 active buds and weighing 25 grams each. The rhizome pieces were planted at a depth of 6 cm in lines in various plots at different spacings i.e. 75 pieces were planted in 45 × 30 cm., 45 pieces in 45 × 45 cm., 56 pieces in 60 × 30 cm., 36 in 60 × 45 cm. and 28 in 60 × 60 cm on 22nd July, 1988 as per experimental design. Support for trailing was provided to the plants after their sprouting. Cultural operation like weeding and hoeings were carried out during the month of June and August for five consecutive years in each replicated plot. The rhizomes were dug out in November, 1983 and the yield of rhizomes was recorded in kg/plot after their cleaning.

## (iii). Testing of different provenances/sources

An experiment was laid out in split plot design,

replicated seven times covering a total area of 1680 m<sup>2</sup> on north-western slope in August, 1978 to study the performance of different sources/provenances of *Dioscorea deltoidea* and effect of application of N and P fertilizers alone or in combination on the yield of rhizome harvested after 6-years rotation. The experimental area was divided into two major plots and 56 sub-plots were demarkated measuring 30 m<sup>2</sup> each. 150 rhizome pieces of 7 cm length with 1 to 2 buds and weighing 3.75 kg per plot were planted in rows 60 cm apart with a distance of 30 cm from plant to plant. Urea fertilizer was applied as N 140 kg/ha, superphosphate as P<sub>2</sub>O<sub>5</sub> 80 kg/ha and N + P (N 140kg and P 80kg/ha) in combination of two was thoroughly mixed in the soil at the time of planting according to the plan. Weeding/hoeing was carried out in June and August every year during the six year's period of experimentation. The crop was harvested in November, 1984 and yield of rhizomes was recorded in kg/plot.

## Results and Discussion

The rhizomes in the trial of support provision were harvested after six year's growth in November, 1983 and yield of fresh rhizomes was recorded in kg/plot. The results are summarised in Table 1.

Table 1.  
Yield of *Dioscorea deltoidea* rhizomes under cultural and fertilizer treatments

Mean yield in kg/plot (12m <sup>2</sup> )			
Level of N (kg/ha)	Support provision	Non-Support	Mean
0	3.414	3.320	3.367
100	4.052	3.470	3.761
150	4.183	3.630	3.907
200	4.008	3.856	3.932
Mean	3.914	3.571	—
LSD (5%) support provision = NS			
LSD (5%) nitrogen = 0.302 kg/plot			
LSD (5%) support provision × nitrogen = NS			

(i). Statistical analysis of results indicated that though support provision had no significant effect, still it gave nominal increase in the yield as compared to no support. However, because of high cost of stakes, the benefit of increased yield of rhizomes was found to be uneconomical. Application of urea at the rate of 217 kg/ha (N-100 kg/ha) gave better yield of rhizomes (3.76 kg/plot) as compared to control (3.36 kg/plot). The yield variation amongst various doses of nitrogen

remained insignificant and showed a trend that application of higher doses of urea would not be beneficial to the plants.

(ii). Yield of rhizomes in spacing trials was recorded after a growth period of five year's in November, 1983 and the results are given below:



Table 2.

Effect of spacing on the yield of rhizomes in kg/plot (8m<sup>2</sup>)

Mean yield of rhizomes in (kg/plot)

Spacing treatment (cm)	Replications					Mean
	1	2	3	4	5	
45 × 30	2.250	2.185	1.505	2.100	2.460	2.300
45 × 45	1.131	1.670	1.774	1.285	1.600	1.504
60 × 30	2.016	1.885	2.250	2.555	2.200	2.181
60 × 45	1.050	1.425	1.575	0.975	1.800	1.365
60 × 60	1.260	1.273	0.910	1.260	1.400	1.221

LSD (5%) = 0.225 kg/plot

Analysis of results showed that plants spaced at 45 × 30 cm and 60 × 30 cm gave significantly higher yield of rhizomes (2.300 kg/plot) and (2.181 kg/plot) respectively as compared to other spacings. Keeping in view of the ease of cultural operations and 25% economy in the seed-rate, a spacing of 60 × 30 cm was found as most suitable as the plants being climbers have a tendency to intervening with each other and thus

narrow spacing of 45 × 30 cm does not allow cultural operations. On the other hand spacings of 45 × 45, 60 × 45 and 60 × 60 cm give low yield of rhizomes.

(iii). Yield of rhizomes of two provenances and sources was recorded in November, 1984, after a period of six years of growth and results are given below:

Table 3.

Yield of two provenances of *Dioscorea deltoidea* under different fertilizer treatments

Mean yield of rhizomes in kg/plot

Fertilizer treatment (kg/ha)	Source/Provenance		Mean
	Galies	Murree	
O	9.817	11.659	10.738
N — 140	10.378	11.581	10.975
P — 80	10.869	12.116	11.492
N+P — 140+80	11.298	12.312	11.805
Mean	10.590	11.917	—

LSD (5%) provenance = 1.243

LSD (5%) fertilizer treatment = NS

It was found that Murree source/provenance gave better yield of rhizomes (11.92 kg/plot) as compared to Galies source (10.59 kg/plot). The mean yield varied under fertilizer treatments and there was nominal increase in yield of rhizomes (11.49 kg/plot) with the application of P and N+P fertilizer (11.80 kg/plot) as compared to control treatment (10.73 kg/plot). As the

experiment continued for a period of six years the effect of fertilizer seem to be diminishing gradually and ultimately no significant difference could be observed. *Dioscorea deltoidea* is a slow growing plant, therefore, a basal dose of N+P together (N 140 and P 80 kg/ha) was found to be beneficial in the initial stages of growth only.



## Conclusion

*Dioscorea deltoidea* rhizomes have slow growth rate due to short growing season of May to October in the high hills. The plant is perennial and requires at least six years to produce rhizomes of commercial size. This study indicated that provision of support and application of fertilizer did not give appreciable yield. Rhizomes of *Dioscorea deltoidea* if planted at spacing of 60 × 30 cm would provide higher yield and ease for agricultural operations. For regeneration of the plant, rhizomes of 7 cm size, weighing 25 cm and having 1 to 2 active buds be planted in the rainy season (July and August) for restocking the area where the population of plants have depleted.

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Yield of two provinces of *Dioscorea deltoidea* under different fertilizer treatments

Mean yield of rhizomes in kg/plot

Fertilizer treatment (kg/ha)	2 years Province		Mean
	Gallies	Plattee	
O	9.817	11.659	10.738
N - 140	10.178	11.581	10.879
P - 80	10.889	12.176	11.482
N + P - 140 + 80	11.292	12.312	11.802
Mean	10.290	11.917	-
	1SD (5%) Province = 1.243		
	1SD (5%) fertilizer treatment = NS		

It was found that Murree source province gave better yield of rhizomes (11.92 kg/plot) as compared to Gallies source (10.29 kg/plot). The mean yield varied under fertilizer treatments and there was nominal increase in yield of rhizomes (1.49 kg/plot) with the application of P and N + P fertilizer (11.80 kg/plot) as compared to control treatment (10.73 kg/plot). As the

experiment continued for a period of six years the effect of fertilizer seem to be diminishing gradually and ultimately no significant difference could be observed. *Dioscorea deltoidea* is a slow growing plant therefore a basal dose of N + P together (140 and 80 kg/ha) was found to be beneficial in the initial stages of growth only.