

**DETERMINATION OF OPTIMUM PERIOD OF GROWTH,  
SUITABLE SEASON OF PLANTING AND EFFECT OF  
FERTILIZER ON THE YIELD OF RHIZOMES OF  
*DIOSCOREA DELTOIDEA* WALL.  
AT KUZA-GALI**

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**Abstract**

Experiments were carried out to determine the optimum period of growth, effect of planting season and application of N & P alone or in combination on the yield of *Dioscorea deltoidea* rhizomes at Kuza-Gali, its natural habitat. Results indicated that yield of rhizomes significantly increased with the increase in duration of time. The yield was optimum after 6 years growth period followed by progressive decline in yield of rhizomes harvested after 8th and 10th years of growth. Monsoon planting provided more number of sprouts and higher yield of rhizomes as compared to fall planting. Application of NP fertilizer at 135 kg N and 65 kg P/ha as basal dose gave higher yield as compared to control.

**Introduction**

Steroidal drugs are the main stay of modern allopathic system of medicines and their importance is increasing day by day with new discoveries. Steroids are used for the preparation of various hormones and in different medicines responsible for regulating growth, calcium metabolism and control of inflammation etc. Marker *et al* (1947) discovered that rhizomes of sapogenin bearing species of *Dioscorea* are extremely good source of diosgenin, a plant steroid which can be easily converted into progesterone and oestrogen in four chemical steps. There are a number of plants from other families such as liliaceae, agavaceae and amaryllidaceae etc. which yield saponin but none of them had proved suitable for industrial processing (Malik & Imam 1966). Only *Dioscorea* spp. bearing sapogenin, are the main commercial source for the production of "diosgenin".

*D. deltoidea* locally known as kanis, a dioecious climbing perennial herb naturally occurs in the moist temperate north-western Himalayan ranges of Pakistan at an altitude ranging from 1900—2500 m. (Abrol and Kapoor 1963). The diosgenin content in rhizome varies from 3 to 4 percent on dry weight basis as reported by Malik and Imam, 1966 and Onwueme, 1973. Sizeable quantities of rhizome can be collected annually from Hazara, Galiat, Dir, Chitral, Swat and Azad Kashmir forest areas for the production of diosgenin. Recently a pilot project for the extraction of diosgenin from kanis rhizome has been initiated by "Kurram chemical company". Approximately 80 to 100 tonnes of rhizomes would be required annually by the company for the preparation of diosgenin and other intermediate products. Since the underground rhizomes are used for the manufacture of the drug, the plant is to be destroyed in harvesting. Moreover, naturally occurring plant

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may not be able to withstand commercial exploitation due to slow growth rate of rhizome and longer periods required for maturity with desired content of diosgenin. Secondly indiscriminate and wanton extraction of rhizomes by the collectors if continued for longer period without proper assessment and inadequate regeneration would result in the extinction of this precious species from more accessible forest areas. Observing the exploitation possibilities, there is a need to propagate the plants in the forest area — the plant natural habitat. Since very little is known about the methods of propagation i.e., season of planting, economical methods of growing, effect of fertilizer on yield of rhizomes and number of years taken by the rhizomes for maturity, therefore, experiments were carried out to develop the propagation techniques of Kanis rhizomes at Kuza Gali. Results of a long-term studies are presented in this paper.

### Materials and Methods

*D. deltoidea* rhizomes were collected from Galiat areas during the month of July, 1976 and later-on rhizomes were cut into 7 cm pieces weighing 25—30 gms. Prior to laying out trials, 24 soil samples from 0—15 cm depth and 24 soil samples from 16—30 cm depth were taken from the experimental site and analysed for physico-chemical characteristics as under:

#### A. Physical parameters

	Depth in cms	
	0 — 15	16 — 30
i. Sand percent	63	55
ii. Silt percent	34	40
iii. Clay percent	3	4

Tex. Class (ISCS System) sandy loam.

#### B. Chemical parameters

i. pH Sat. Paste	7.5	7.6
ii. CaCO <sub>3</sub>	—	—
iii. EC x 10 <sup>3</sup>	0.35	0.12
iv. TSS percent	0.09	0.06
v. OM percent	3.61	1.20
vi. Total N percent	0.18	0.17
vii. P <sub>2</sub> O <sub>5</sub> ppm	26.00	20.00
viii. K <sub>2</sub> O ppm	291.00	129.00

A long term field experiment (1976—1986) was carried out at Kuza-Gali forest enclosure (moist temperate, elevation 2500 m, 1650 mm annual rainfall with annual snow-fall of 122 to 150 cm). The variables to be tested were growth periods, season of

planting and application of N, P alone or in combination, on the yield of rhizome. The experiment was designed in split split plot design with six replications, having 5 growth periods (a unit to be harvested after 2, 4, 6, 8 and 10 years) as first split, two planting seasons (monsoon vs fall) as second split and four fertilizers (O, N, P and NP) applications as third split. The size of sub-plot was kept as 30 m<sup>2</sup>. One hundred and twenty plot were planted in monsoon season i.e. August, 1976 and the same number of plots were planted in fall (November 1976). In each sub-plot 1.350 kg rhizome pieces (150) were planted at a depth of 8 cm in 3 rows 60 cm apart, maintaining a distance of 30 cm from plant to plant, thus covering a total area of 7300 m<sup>2</sup> on southwestern aspect having moderate slope. The prominent tree species were *Pinus wallichiana* and *Abies pindrow* which formed mixed canopy on that aspect. Urea fertilizer as N 135 kg/ha, super phosphate as P 65 kg/ha and NP was a combination of two (135 kg N and 65 kg P/ha) were applied as a basal dose at the time of planting according to lay out plan. No fertilizer was given to the plot kept as control (O). Usual weeding/hoeing was carried out in June and August each year to suppress the growth of weeds. Support of Kanas (*Saccharum erianthus*) was provided to the plants for trailing from May to October each year. Rhizomes were dug up from plots relegated to relevant treatments in November after 2, 4, 6, 8 and 10 years growth respectively and yield of rhizome was recorded in kg/plot as per experimental design.

## Results

Mean yield of fresh rhizomes (kg/plot) as affected by different growth periods, various cultural and fertilizer treatments are given as under:

Treatment	Weight of rhizomes planted/	P1: yield after 2 years growth 1976—78		P2: yield after 4 years growth 1976—80		P3: yield after 6 years growth 1976—82		P4: yield after 8 years growth 1976—84		P5: yield after 10 years growth 1976—86	
		FP	MP	FP	MP	FP	MP	FP	MP	FP	MP
O	1.35	2.27	3.17	5.45	5.75	9.37	8.87	6.87	7.78	4.84	4.90
N	1.35	2.72	3.25	5.88	5.93	10.25	11.15	7.60	10.05	5.48	5.67
P	1.35	2.87	3.20	5.80	6.08	9.97	10.95	8.95	9.72	6.17	5.85
N P	1.35	2.57	3.60	6.16	6.50	11.43	11.89	7.16	10.03	6.40	6.27

Growth period mean yield (kg/plot)	P1	P2	P3	P4	P5
	2nd year	4th year	6th year	8th year	10 year
	2.93	5.94	10.47**	8.51	5.70

LSD at 1% = 0.710

Planting season mean yield	FP	MP
		6.40

LSD at 1% = 0.44				
Fertilizer mean yield (kg/plot)	O	N	P	N P
	5.91	6.78	6.95	7.20*
LSD at 5% = 0.48				

FP = Fall planting, MP = Monsoon planting, N = Nitrogen,

NP = Nitrogen & Phosphorus, P = Phosphorus.

\*\* = Mean difference is significant at 1% probability level

\* = Mean difference is significant at 5% probability level

### Discussion

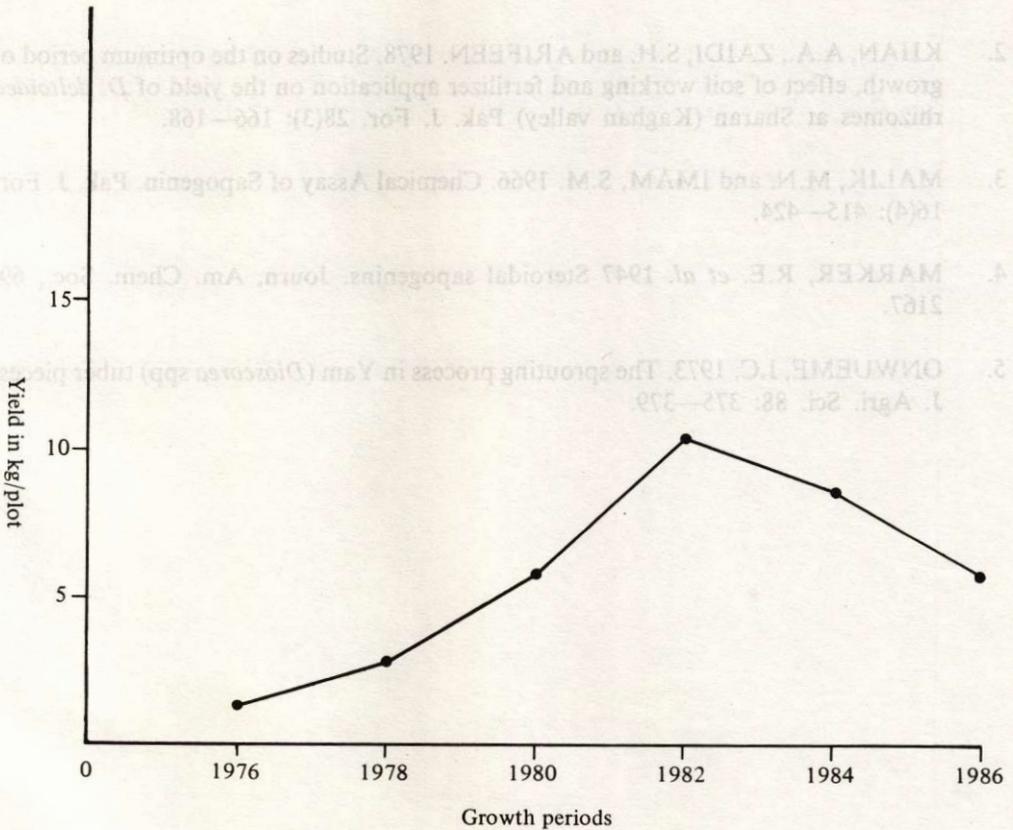
The yield of rhizomes significantly increased with duration of time i.e., from 2 years, to 6 years growth (2nd year 2.93 kg, 4th 5.94 kg and 6th year optimum yield upto 10.47 kg/plot as compared to weight of planted rhizomes; 1.35 kg), followed by decline in yield after 8 and 10 years growth as shown in the graph. Monsoon planting gave significantly higher yield of rhizomes (7.02 kg/plot) as compared to Fall planting (6.40 kg/plot) which confirmed the previous results (Khan *et al.* 1978). Application of NP fertilizers as basal dose gave significantly higher yield (7.20 kg/plot) as compared to control treatment (5.91 kg/plot). No significant difference in yield was observed amongst various fertilizer treatments. Rhizomes samples from 6 years growth onward on chemical analysis, contained 4 to 5% diosgenin, it was a bit low in the first four years of growth.

### Conclusion

*D. deltoidea* an important pharmaceutical plant naturally occurs in moist temperate Himalayas where annual growth period is hardly 5 to 6 month which results in the slow rhizomatous growth. The rhizome takes many years to reach adequate stage for harvest as indicated by the experimental results. The following measures are suggested to prevent depredation of this species in its natural habitat.

- (i) Six years rotation for extraction of *D. deltoidea* rhizome may be adopted in various forest blocks to provide sufficient growth periods to the plant for regeneration and vigorous growth.
- (ii) Indiscriminate extraction of rhizomes should be discouraged and forest authorities may impose condition on the contractors to leave 1/4th portion of the rhizome in the soil during digging operation for regeneration.
- (iii) The worked out blocks may be closed for 6 years and extraction of material may be banned from the block.
- (iv) The depleted areas where *D. deltoidea* had become scarce should be planted with rhizome pieces of 7 to 8 cm length with one or two active buds at a spacing of 60 cm in

Curve showing optimum period of growth after six years followed by progressive decline during the last four years.



rows and 30 cm from plant to plant in rainy season. This practice would help to conserve the germplasm resources and ensure its future supply from forest of hilly areas.

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