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INFLUENCE OF FERTILIZERS ON GROWTH OF RAUVOLFIA SERPENTINA

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Abstract

Medicinal plants ought to have been given the status of a national resource. This is why their availability is essential to sustain one of the world's oldest medical traditions, a priceless legacy of Indian people. Over one and a half million practitioners of the Indian Systems of Medicine, in the oral and codified streams, use medicinal plants in preventive, promotive and curative applications. While the demand for medicinal plants is on increase, their survival in their natural habitats is under growing threat. One strategy for maintaining balance between demand and supply is commercial propagation of the plant in addition to its rational and judicious use. The manures and fertilizers have profound effect on plants growth. Fertilizers are mainly inorganic and commonly synthetic material, which are rich in one or more of the essential plant nutrients. Visualizing the importance of R. serpentine, the proposed research work deals with the study of effect on the application of various combinations of FYM, N,P and K on its growth Similar trends in the growth of shoot height and collar diameter were observed in different treatments in first and second year of plant growth. However, maximum gain in height was found in the plants of the treatment NP. Maximum gain in collar diameter was recorded in the treatment P.

***Keywords**: Rauvolfia serpentine**;** Fertilizers; Plant Growth; Medicinal plants.*

Plants have been associated with the health of mankind from the time immemorial. The study of medicinal plants in India was at the peak of its glory during the Vedic period (2000BC-800BC). "Vrikshayurveda" a treatise written by Sangadhara during the Pre-Christian era was the most authentic textbook on herbal medicine in ancient India. The Charaka Samhita, an encyclopaedia of Indian medicine (between 1000 BC and 100 AD) is a comprehensive record of medicinal plants and their uses includes *Rauvolfia serpentina* Benth.

ex Kurz. It is known as *Sarpagandha* (the snake root) in Hindi and belongs to family Apocynaceae. The snakeroot plant has been a part of Ayurvedic medicine for thousands of years. The plant is well described in Dravgun Vigyan of Ayurveda (Sharma, 2001).

R. serpentina is indigenous to the moist, deciduous forest of South East Asia including Burma, Bangladesh, Sri Lanka, Malaysia, Andaman Islands and Indonesia. On account of the fact that the derivatives of medicinal plants are non-narcotic and having no side-effects, the demand of these plants is increasing in both developing and developed countries. Most of the drug is obtained from wild sources in these countries. It is also cultivated on small scale in India and Bangladesh. *Rauvolfia* species are threatened in India due to indiscriminate collection and over exploitation of natural resources for commercial purposes to meet the requirements of the pharmaceutical industry. It is in threat status assessed in year 1990 (Nayar *et. al*., 1990). Later, the Botanical Survey of India in 1995-99 declared the species rare (Notification No. 24 (RE-98) / 1997-2002). For the conservation of the species in the wild, the plant under threat can be grown commercially.

The plant is an erect, perennial herb with about 60 to 90 cm in height (fig.-1). Stems are usually unbranched, slender and have pale bark. Its leaves are simple, 7.5-10 cm long and 3.5-5cm broad, eliptic or lanceolate, glabrous, bright green above and pale green beneath, pointed usually more crowded towards upper part of stem, mostly 3-whorled, or a few leaves occasionally opposite or even alternate (leaves described as varying from opposite to 3-5-whorled). Flowers are borne in a two to four nate cyme, the calyx is five lobed, the corolla salver shaped, its tube is pinkish, cylindrical and slender. In early stages, the inflorescence is light green; but when the flowers open they show white corollas with a reddish tinge on the outer side. At the later stage, in the mature inflorescence, the axis, pedicels and calyx assume a bright coral red colour (fig.-1). The spherical fruit is a drupe, 0.5 cm in diameter, single or double, the colour changes from green to red and jet shiny black when fully ripe (fig.-1).

The growth and development of plants are determined by numerous factors of soil and climate as well as by those factors inherent in the plants themselves. The successful production of the crop depends on the adequate supply of all the necessary nutrients, which plants take from the soil. There should be a balance between them in accordance with the amount needed by plants. Thirteen mineral nutrients are essential for growth and development of all plants, categorized into three groups (Tandon and Ranganathan, 1976) namely primary (Nitrogen, Phosphorus and Potassium), secondary (Sulphur, Calcium and Magnesium) and micro (Zinc, Iron, Manganese, Copper, Boron, Molybdenum and Chlorine). If any of these elements lacks or is present in improper proportion, normal plant growth will not occur. The supply of needed nutrients can be managed by adding manures/fertilizers. According to Gupta (2003), plants need 16 elements for their growth and completion of life cycle classified into three groups basic, macro and micro. Macronutrients are N, P, K, Ca, Mg and S and are required in large quantities. Among these, N, P and K are called primary or major nutrients and are the most important and often deficient in almost all the soils because of their heavy depletion. The deficiency is corrected by application of fertilizers.

The manures and fertilizers have profound effect on plants growth. Organic manures are natural products or a product of combination of natural matters. For many years, manuring has been known to be perhaps the most logical and practicable method of aiding in the maintenance of soil productivity. Most cultivated soils give marked increase in yield. The biggest returns from manures are realized only when it is used in conjunction with other good soil management practices. Manures most widely used at present are traditional farmyard manures (FYM) and are generally recognized as a most valuable by product of the farm.

Fertilizers, in a broad sense, include all materials that are added to soil to increase the growth or yield of crop. Fertilizers now days are mainly inorganic and commonly synthetic material, which are rich in one or more of the essential plant nutrients. Although, fertilizers may affect the soil and plant growth in different ways, they are used primarily to increase the supply of available nutrients in the soil and are also used to balance the plant nutrient ratio. Many years of experimentation have shown that the greatest effects of fertilizer nutrients on crop yields have been brought about by nitrogen, phosphorus and potassium (Dalan *et. al*., 1949). Fertilizers do not consist of these elements as such, but they are combined with other elements to form either organic or inorganic compounds. Balanced use of fertilizers (N, P and K) at appropriate time is an essential step for maintaining proper fertility status of the soil and also for obtaining maximum yield of superior qualities. Mineral fertilizers play an important role in sustaining and increasing production. The basic need of crop production is to maintain soil fertility and soil productivity. Before deciding the quantity of fertilizers application, analysis of the soil for the determination of available NPK/ha must be carried out (Mengel and Kirkby, 1987; Singh and Sahi, 2005). The ideal way to fertilize a field is to apply fertilizers on the basis of actual requirements as ascertained by local soil tests. The 4R constitute essential components for efficient fertilizer management. These are right type of fertilizer, right dose of fertilizer, right method of application and right time of application (Gupta, 2003). Lachover and Arnon, 1966 have also stated about interaction of nutrients i.e. the law of minimum operates in the responses of two essential nutrients required for optimum growth. The maximum effect of one particular plant nutrient can only be expected, if the supply of other plant nutrient is adequate for which the ratio of plant nutrients are also important. This ratio depends on soil fertility status, crop species and crop management (Mengel and Kirkby, 1987). Goswami suggested a concept of balanced fertilization and gave a generalized equation for the same (Gupta, 2003). BF = f (soil type, crop/cropping system, inputs, residual effects, available soil nutrients, yield targets, economics of fertilizers use and time). The absorption pattern of different nutrients by plants at their growth stages decides the time of fertilizer application. It mainly depends on the nature of the crop, its growth stages, soil conditions, nature of fertilizers etc. Fertilizer N is highly mobile and may lost through volatilization and leaching therefore, a part of N should be applied at the time of sowing and the remaining quantity in split doses during the period of crop growth. Since P and K are required at early growth stages and are less mobile, the entire quantity of these may be applied at the time of sowing (Gupta, 2003).

According to Anon (1998), the use of organic manures leaf mould and compost increases the quality of nutrients in the soil. Nitrogenous fertilizers induce more vegetative growth and root growth. He recommended to apply a basal dose of 30 kg / ha of K_2O and P_2O_5 and 20 kg /ha of N before planting. Two doses as top dressing of N should also be applied during the growth. Shiva (2002) reported that mixing of FYM/compost is beneficial for more vegetative growth and nitrogenous fertilizers along with K_2O and P_2O_5 should be mixed in the soil before planting. Use of organic manure/compost along with nitrogen, K_2O and P_2O_5 produce better results if applied as basal dose. Anon (2004) suggested that nitrogen 30 kg, phosphorus 60 kg per hectare with 8 tons of FYM should be mixed in the soil (split doses) before plantation. Singh and Sahi (2005) suggested that 60 kg N, 40 kg P and 40 Kg K per hectare should be used for better results of *R. serpentina.*

From the review of literature, it was found that growth of the plants have been increased by the application of fertilizers and very scanty and contradictory information are available regarding the use of FYM and fertilizer and its effect on the growth of *R. serpentine* in split doses (Anon, 1997b; Maheshwari *et. al.*, 1988; Anon, 2004; Jaryal, 2004). It is worth to mention here, that contradictory doses of FYM and fertilizers have been suggested and no concrete dose of fertilizers for the *R. serpentina* has been recommended. However, no work has been carried out on the influence of combination of fertilizers on the growth of *R. serpentina.* Therefore, the present research was taken in hand to study the effect of various combinations of NPK as well as FYM on growth of *R. serpentine* and application of various combinations of N, P and K is subjected for the study. The present endeavour is made to assess the requirements of three major elements mainly nitrogen, phosphorus, potassium in various combinations (FYM, FN, FP, FK, FNP, FNK, FPK, FNPK, N, P, K, NP, NK, PK, NPK) to get maximum growth of *R. serpentina*.

Methodology

The experimental site was in the F.R.I. campus. The field selected was 40 m long and 16 m wide having 2.5 m to 3.5 m high lantana bushes, which were uprooted for clearing. The tractor hoed the whole field carefully, leveling an area of 30 m X 13 m. Forty-eight plots of equal size were prepared for the experiment according to the plan in the area of 311.91 m^2. Before sowing of seedlings, soil samples of the experimental plot were taken randomly from different parts of the field. These were collected from 0 to 30 cm depth and analyzed for its physical and chemical properties. Sixteen treatments (T to T15) of fertilizers consisting various combinations (table-1) were selected for the experiment including the control (T). Three replications of each treatment were carried out. The doses selected for FYM, N, P and K were 25 t/ha, 60 kg, 30 kg, 30 kg per hectare respectively (Anon, 1998; Rao *et. al.*, 1999; Chandra and Pandey, 2004).

Table -1: Showing Combinations of Fertilizers

Treatment	Fertilizers	Quantity /ha
T	**Control**	-
T 1	FYM	*25 ton*
T 2	FN	25 ton, 60 kg
T 3	FP	25 ton, 30 kg
T 4	FK	25 ton, 30 kg

T 5	FNP	25 ton, 60 kg, 30kg
T 6	FNK	25 ton, 60 kg, 30kg
T 7	FPK	25 ton, 30 kg, 30kg
T 8	FNPK	25 ton, 60 kg, 30kg, 30kg
T 9	N	60 kg
T10	P	30 kg
T11	K	30 kg
T12	NP	60 kg, 30 kg
T13	NK	60 kg, 30 kg
T14	NPK	60 kg, 30 kg, 30 kg
T15	PK	30 kg, 30 kg

The experimental area (30 m X 13 m) was ploughed mechanically quite deep. The weeds were removed and an area measuring 28.1 m X 11.1 m was prepared for the transplantation of seedlings. 48 equal plots of 2.40m x 1.80 m size were prepared (fig.-2). According to the plan, different combinations of fertilizers were applied (table-1) in these plots.

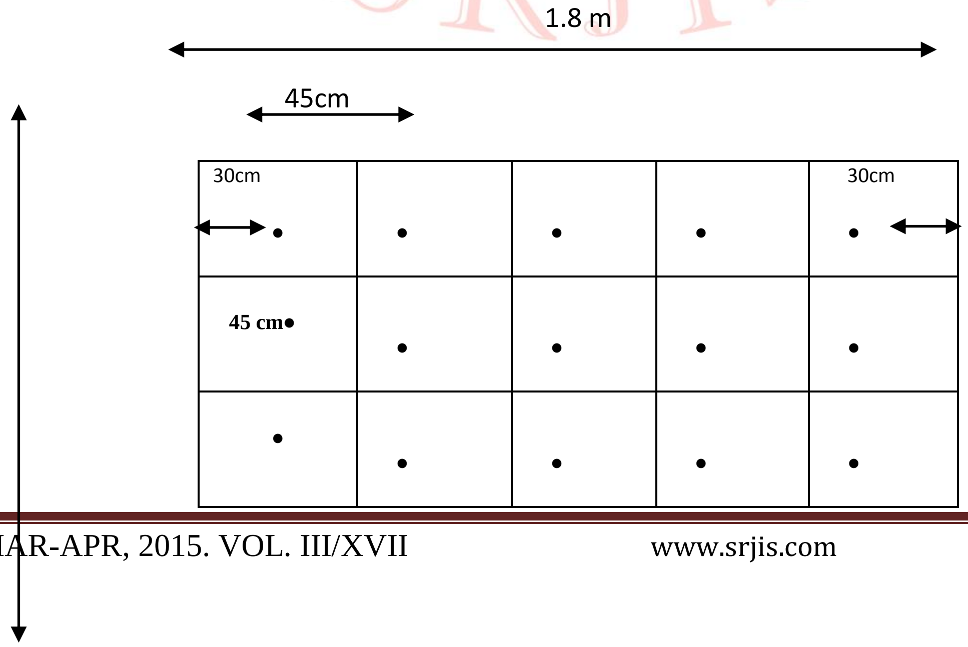
Table -2: Quantity of Fertilizers Applied

Fertilizer	Element	Available %	Quantity/ha
Urea	N	46	130 kg
Single Super Phosphate	P_2O_5	16	187.50 kg
Muriate of Potash	K_2O	60	50 kg

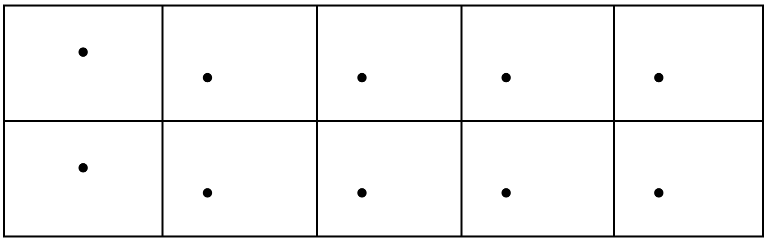
Table –2 shows the quantity of fertilizers N, P and K applied in the plot per hectare. Judicious use of fertilizers includes proper choice and dosage of fertilizers as well as appropriate time and method of their application. Nutrient requirement of crop differ significantly during different growth stages. Plants absorb nitrogen throughout their growth period whereas phosphate is absorbed at a faster rate during early growth period because it helps in growth and development of roots. Similarly, is the case with potash, however, it helps in translocation of plant nutrients, water and photosynthesis within plant the body throughout active growth. Fertilizer, nitrogen is highly mobile and may be lost through volatilization and leaching, if not utilized by the plants. Therefore, it was applied in split doses during the period of plant growth. Potassium and phosphorus are less mobile in comparison to nitrogen, so the entire quantity was applied at the time of transplantation (basal dose). 30 kg of nitrogen per hectare was applied as basal dose and 30 kg per hectare after 50 days of transplantation. 30 kg of phosphorous and 30 kg of potassium per hectare were applied as basal dose before transplantation. Well rotten FYM at the rate of 25 tons per hectare was applied as basal dose in the plots before transplantation.

A distance of 0.50m was kept between two plots. Rows of slightly raised mounds (merh) were made in every plot for transplantation. Row-to-row distance was kept 45 cm and plant-to-plant distance in a row was 30 cm. Healthy seedlings (1200 no.) from root trainers were selected (fig.-3) for transplantation according to the plan in the 48 prepared plots. 25 seedlings were transplanted in each plot, as 3 replications of each treatment were to be carried out therefore, 75 seedlings (25x3) of each treatment were transplanted (fig.-4). The plots were observed and maintained regularly. The field was kept relatively weed-free during the period of growth (fig.-5). Four weedings along with soil working were carried out in the months of October 03, February 04, July 04 and October 04. A contact insecticide Cypermethrin (0.02%) and fungicide Radomil were sprayed on leaves in August 03 and 04 to protect the plants from various diseases and pests.

Pattern of Seedlings Transplantation in a Plot



2.4 m



Tables-3: Details of Layout

Sl. No.	Description	Plan
1.	Design	Randomized Block Design (Factorial)
2.	Replication	Three
3.	No. of Treatments	16
4.	Total No. of plots	48
5.	Gross field size	40 m x 16m
6.	Net experimental area	28.1 m X 11.1 m
7.	Distance between replications	1 m
8.	Distance between plots	0.50 m
9.	Size of a single plot	2.40 m x 1.80 m
10.	No. of Rows in a plot	5
11.	Distance between rows	0.45 m
12.	Plant to plant distance in a row	30 cm
13.	No. of plants per plot	25
16.	Crop duration	March 2003 to Jan. 2005

Table- 3 presents the detailed layout of the experiment. The experiment was laid down as per the Randomized block (factorial). Three replications were carried out and in each replication, sixteen treatments were randomly distributed (layout plan). 25 plants in each treatment were transplanted (25 X 3 = 75 plants). Net area of the experiment (28.1 m X 11.1 m) was divided into 48 plots. There were 5 rows in each plot. Row-to-row distance was 45 cm in a plot and plant-to-plant distance was 30 cm in a row. The crop duration was from March 03 to January 05.

Morphological observations on height and collar diameter were recorded on 5 plants selected from each plot in each replication and were recorded quarterly (Fig.-6) during the period of crop growth.

Shoot Height (cm): During the crop growth, shoot height was recorded on 5 randomly selected plants from each plot in each replication. Height was measured from shoot tip to the surface of the soil (collar). These were recorded in the months of July 03, October 03, January 04, April 04, July 04, October 04 and January 05.

Collar Diameter (mm): Similarly, the diameters at the collar of the selected plants were taken as collar diameter. This was measured by digital Vernier caliper and was recorded in the months of July 03, October 03, January 04, April 04, July 04 and October 04.

Result and Discussion

The results obtained are presented below.

Table -4: Details of Cultural Operations with Time

Sl. No.	Operations (Feb 03 to Jan. 2005)	Time
1.	Cleaning of plot	Feb 03
2.	Preparation of potting media	March 03
3.	Ploughing of field mechanically	June 03
4.	Preparation of experimental plots	June 03
5.	Transplantation of seedlings	July 03
6.	Watering of plots	When required
7.	Weeding and soil working	Oct. 03, Feb. 04, July 04 & Oct. 04
8.	Application of fertilizers	July 03, Sept. 03 and July 04
9.	Data collected	July 03, Oct. 03, Jan. 04, April 04, July 04 and Oct. 04 & Jan. 05.

13.	Spray of insecticides	Aug. 03 and 04
14.	Spray of fungicides	Aug. 04

Table-5: Physical Analysis of Soil

Sl. No.	Soil Component	Content (%)	Method of determination
1.	Sand	45	Piper (1966)
2.	Silt	25	
3.	Clay	30	

The result of soil description are presented in table-5. The soil of the experimental area was analyzed by the method given by Piper (1966). The soil of the area was found silty clayey loam with 45 % of sand, 25 % of silt and 30 % of clay.

Table-6: Chemical Analysis of the Soil

Sl. No.	Soil Component	Value		Method of determination
		%	Per Ha	
1.	Organic Carbon	1.04		Walkey and Black method (1934)
2.	Organic Matter	1.79		
3.	pH	7.0		
4.	Available N	0.023	515 kg	Alkaline permanganate method (Subbiah and Asija, 1956)
5.	Available P	0.004	89 kg	Olsen's method (Olsen, 1954)
6.	Available K	0.007	156 kg	Flame photometer method

Table –6 presents the chemical analysis of the soil. The pH of the soil was observed 7.0 by soil: water suspension. Organic carbon and organic matter in the soil were found to be 1.04 % and 1.79 % respectively. The percentage of N, P and K was obtained 0.023 %, 0.004

% and 0.007 % respectively or 515 kg, 89 kg and 156 kg per hectare in the same order. According to Gupta (2003), the quantity of P was high and N as well as K was medium in the soil.

Climate

The Doon valley lies between latitude 30 to 33°32′ N and longitude 77° 43′ to 73° 24′ E. It is an open valley enclosed by Shiwalik hills in the South, upper Himalayas in the North, Yamuna River on the West and Ganga on the East (Srivastava and Kumar, 2003). The valley is protected from the extremes of climate. The meteorological data viz. maximum and minimum temperature, relative humidity in the morning and in the evening, rain fall, bright sunshine hours and wind velocity were recorded during the crop growth during the years 2003 and 2005 and are depicted in fig 7-9.

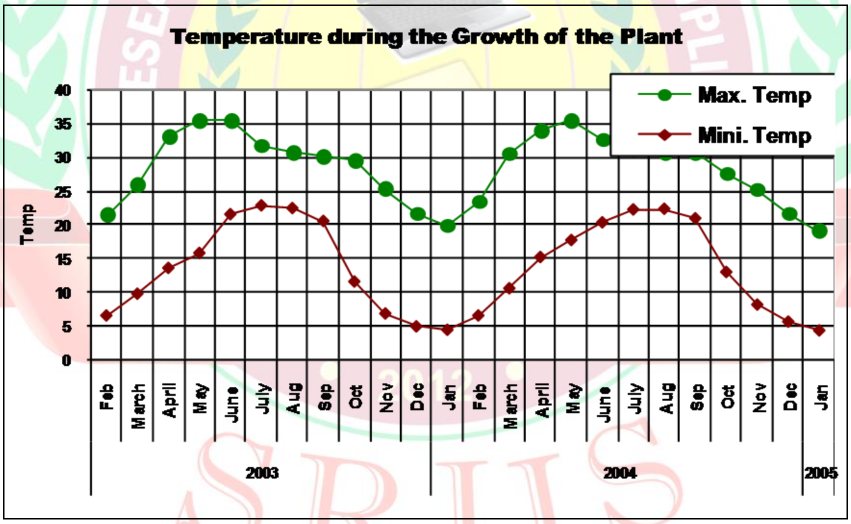


Fig.-7: Temperature during the Growth of the Plant

Fig.-7 depicts that temperature was maximum in the months of May and June and was minimum in the month of January in both the years.

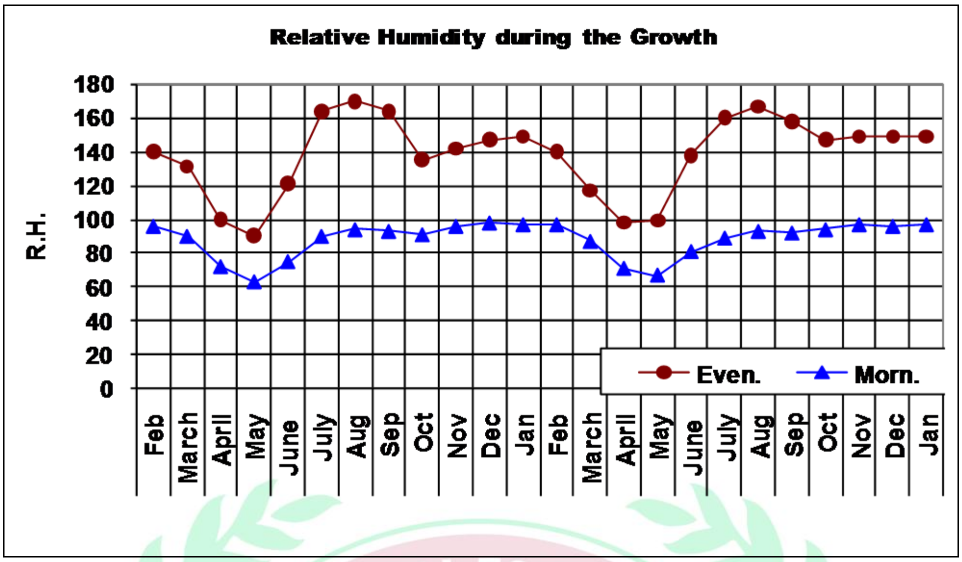


Fig.-8: Relative Humidity during the Growth of the Plant

The relative humidity recorded in the morning and in the evening during the growth period of the plant is shown in fig.-8. Maximum humidity was recorded in the month of August and minimum in the month of May. Relative humidity in the morning ranged from 63 to 98 and in the evening from 27 to 76 percent respectively.

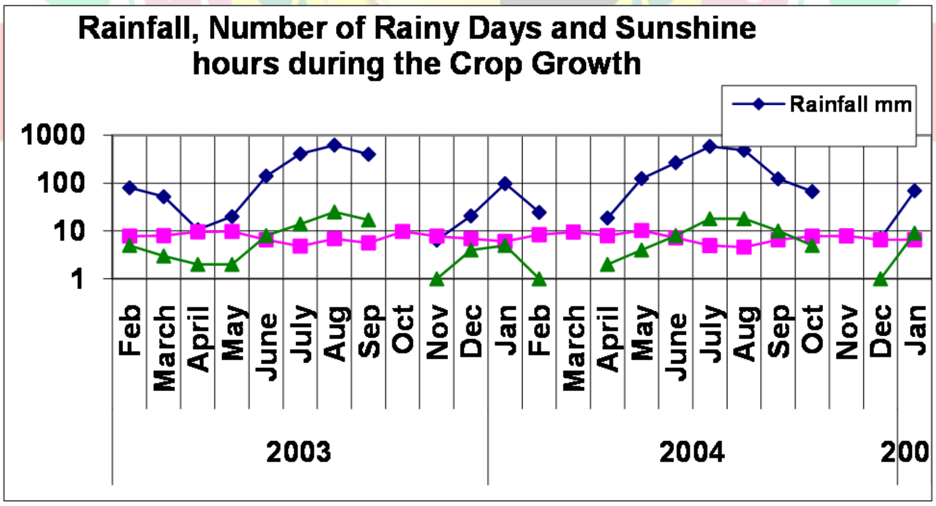


Fig.-9: Rainfall, Rainy Days and Sunshine hours during the Growth of the Plant

Fig - 9 presents that maximum rainfall occurred in the month of August followed by July and September in the year 03. In the year 04, maximum rainfall has recorded in July followed by August. Bright sunshine hours were recorded more in the months of April, May and September in the year 2003, March and May in the year 2004. Number of rainy days was maximum in the months of August 03 and July and August 04 whereas minimum rainy days were recorded in the months of November, February and December in the years 03 and 04.

Preparation of Plots and Application of Fertilizers

Table -7: Availability of NPK in different combinations

Treatments	N (kg /ha)	P (kg/ha)	K (kg/ha)
T	515.2	89.6	156.8
T 1	555.2	109.6	236.8
T 2	615.2	109.6	236.8
T 3	555.2	139.6	236.8
T 4	555.2	109.6	266.8
T 5	615.2	139.6	236.8
T 6	615.2	109.6	266.8
T 7	555.2	139.6	266.8
T 8	615.2	139.6	266.8
T 9	575.2	89.6	156.8
T10	515.2	119.6	156.8
T11	515.2	89.6	186.8
T12	575.2	119.6	156.8
T13	575.2	89.6	186.8
T14	575.2	119.6	186.8
T15	515.2	119.6	186.8

Table – 7 shows total available quantity of N, P, and K per hectare to the plant through different treatments including the calculated value (table – 2) of available N, P and K kg/ha in the soil . The quantity of N, P and K available to the plants in 25 t/ha of FYM are 40 kg, 20 kg and 80 kg respectively (Cooke, 1972).

Table-8: Effect of Fertilizers on Height of the Plant

(From July 03 to Jan 05)

Treatments		Height in cm							
		July 03	Oct. 03	Jan. 04	April 04	July 04	Oct. 04	Jan. 05	Gain
T	Control	15.5	26.72	34.26	40.96	52.32	66.12	72.4	56.9
T 1	F	12.1	24.66	37.4	46.28	57.84	68.6	75.2	63.1
T 2	FN	10	24.84	35.08	46.54	59.18	74.14	83	73
T 3	FP	8.8	21.04	33.06	42.36	55.4	66.2	73	64.2
T 4	FK	10.82	25.48	38.16	51.12	65.86	77.92	85.2	74.38
T 5	FNP	9.18	21.7	32.8	44.78	56.32	65.8	72.4	63.22
T 6	FNK	7.7	21.56	31.92	44	55.4	66.1	71.4	63.7
T 7	FPK	11.92	24.76	37.1	49.94	62.84	72.86	79.7	67.78
T 8	FNPK	10.72	23.2	34.84	46.36	57.34	67.92	75	64.28
T 9	N	10.1	21.06	32.18	44.58	56.57	65.78	73.4	63.3
T10	P	10.7	24.38	36.36	47.3	60.98	71.96	79.6	69
T11	K	12.4	27.1	40.28	54.38	67.78	80.5	88.2	75.8
T12	NP	11.2	25.06	38.5	53.93	70.84	83.3	92.8	81.6
T13	NK	11.2	24.42	37.56	50.96	65.42	79.56	86.6	75.4
T14	NPK	13.1	24	36.28	47.64	60.16	70.7	79.6	66.5
T15	PK	10.4	19.86	30.36	41.04	53.36	63.82	72.4	62

The results obtained related to the growth of height of different treatments are presented in table -8. It depicts that the growth of height of the plants of all treatments vary significantly with the control. In January 04, the height of plants was ranged from 30.36 cm to 40.28 cm, maximum height in the treatment K and minimum in PK whereas in January 05, it was ranged from 71.4 cm to 92.8 cm, maximum height in NP and minimum in FNK. Maximum gain in height was obtained in NP (81.6 cm) followed by the plants of the treatments K and NK (75.8 cm and 75.4 respectively) whereas minimum gain in height was found in the control (56.9 cm).

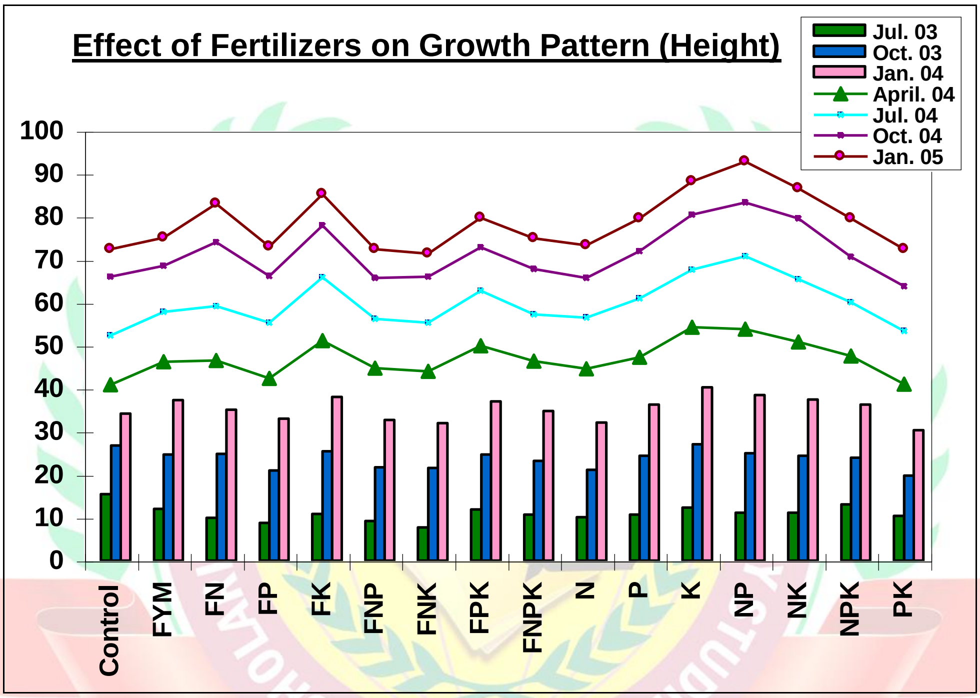


Fig.- 10: Effect of Fertilizers on Growth of Height

From fig.-10, it can be interpreted that growth pattern of height of various treatments show similar trend in first and second years i.e. Jan. 04 and Jan.05 except the plants of NP, which has shown relatively increase in height in second year.

Collar Diameter

The diameter at the collar of the plant was taken as collar diameter of the plant. This was measured by digital Vernier caliper (in mm).

Table-9: Effect of Fertilizers on Collar Diameter

(From July 03 to Jan 05)

Treatment	*Collar Diameter in mm*							
	July 03	**Oct. 03**	**Jan. 04**	**April 04**	**July 04**	**Oct. 04**	**Jan. 05**	**Gain**
Control	2.20	3.74	6	7.51	8.98	10.03	11.25	9.05
F	1.92	3.23	4.93	6.41	7.79	9.18	10.33	8.41
FN	1.99	3.59	5.2	6.19	7.54	8.78	9.6	7.61
FP	1.79	3.83	5.06	6.69	8.62	10.43	11.85	10.06
FK	1.64	3.46	4.99	6.55	8.5	10	11.14	9.5
FNP	1.85	3.22	4.82	6.31	7.92	9.2	10.22	8.37
FNK	1.64	3.04	4.26	5.96	7.47	9.24	10.29	8.65
FPK	1.96	3.32	4.73	6.06	7.45	8.75	9.98	8.02
FNPK	1.81	2.92	4.73	6.01	7.49	8.77	9.84	8.03
N	1.68	3.46	5.26	7.09	8.66	10.44	11.69	10.01
P	1.72	3.58	5.63	7.57	9.45	10.84	11.95	10.23
K	2.08	3.67	5.57	7.41	9.04	10.78	12.25	10.17
NP	1.97	3.6	5.34	7.03	8.79	10.04	11.22	9.25
NK	1.98	3.69	5.31	7.33	9.07	10.7	11.9	9.92
NPK	1.95	3.34	4.71	6.21	7.59	8.99	10.05	8.1
PK	1.72	2.65	4.03	5.43	6.64	7.91	9.26	7.54

The result of effect of different fertilizers on the growth of collar diameter is presented in table-9. Collar diameter was ranged from 4.03 mm to 6 mm, maximum in the control and minimum in PK in January 04, and ranged from 9.26 mm to 12.25 mm in January 05, maximum was recorded in K and minimum in PK. Maximum gain was noted in the treatment P closely followed by K and minimum in PK.

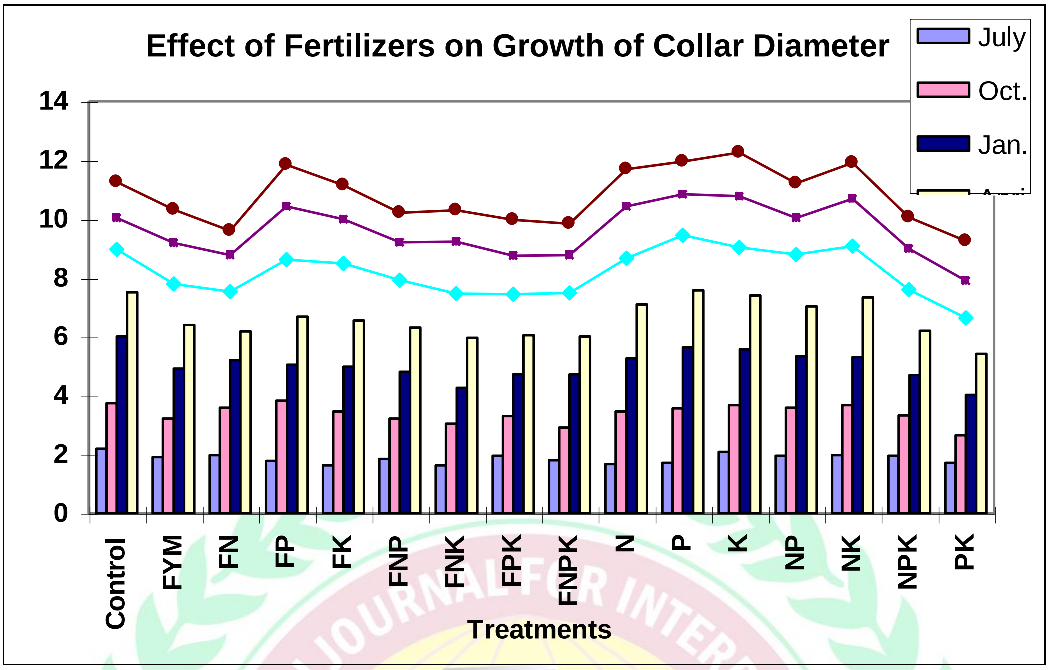


Fig.-11: Effect of Fertilizers on Growth of Collar Diameter

From the fig.-11, it is clear that growth pattern of collar diameter of various treatments show similar trend in first and second years. It was increased in the treatment FP in second year however, maximum gain in collar diameter was found in the plants of the treatment P.

Shoot height

From the results obtained, it can be interpreted that plant growth is affected by the supplementation of fertilizers. Maximum gain in height was obtained in the plants under NP treatment. It was observed that the plant responds better to chemical fertilizers than to organic manure. As reported, phosphorus plays a significant role in the plant growth. Similar observations have been reported by Anon (1986), Farooqi and Sreeramu (2001). Nitrogen is a constituent of every living cell and plays an important role in the encouragement of vegetative growth. It helps in plant metabolism by virtue of being an essential constituent of diverse types of metabolically active compounds like amino acid, protein, nucleic acid, etc. If the nitrogen supply is a limiting factor then growth, flowering and fruiting are adversely affected subsequently, consequently. Nitrogen is essential for plant growth as it is a constituent of all proteins and hence of all protoplasm. As the level of nitrogen supply increases compared with other nutrients, the extra protein produced allows the plant leaves to grow larger and hence to have a larger surface available for photosynthesis (Russell, 1963).

He also stated that the root crops benefit from only nitrogen manuring. Nitrogen is the basic nutrient, which forms chlorophyll, amino acids, proteins, alkaloids and protoplasm. Since the amount of chlorophyll determines the carbohydrate synthesis, nitrogen may be said to control this activity (Anon, 1986). A high rate of growth only occurs when abundant nitrogen is available (Mengel and Kirkby, 1987). They further stated that the level of N that should be applied to a crop depends largely on the particular crop species and on the prevalent soil conditions.

Phosphorus is also an essential constituent of several organic compounds present in seeds in larger amounts and found extensively in the growing parts. It is necessary for normal transformations of carbohydrates, assimilation of fats in plants and increases the efficiency of the chloroplastic mechanisms. It is involved in the basic reactions of photosynthesis for the activation of a number of enzymes in the dark reactions. Its deficiency is characterized as low organic P / inorganic P ratio in plants. Sometimes, it results in an increased accumulation of free reducing sugars, indicates involvement of phosphorus in carbohydrate metabolism. Thus, phosphorus plays a significant role in energy transformation and metabolic processes of plants. Optimum quantity of phosphorus available to the crop in combination with nitrogen balances their shoot and root growth (Anon, 1986).

Potassium is also an essential element involved in many vital physiological processes in plants. It plays important role in maintenance of cellular organization by resulting the permeability of cellular membrane and keeping the protoplasm in proper degree of hydration by stabilizing the emulsions of highly colloidal particles. Potassium salts have great buffering action and stabilize various enzyme systems. Apart from its organizational and electro-chemical role, potassium plays a catalytic role by activating a number of enzymes, catalyzing the incorporation of amino acids in protein. The synthesis of peptoid bonds and phosphate group transfer, particularly in bacteria, some of these enzymes e.g. aldehydes dehydrogenase, phosphate acetyl transferase and □-galactosidose require potassium for their optimum activation. The N containing organic compounds in FYM are much more resistant to decomposition and only about one third of the N is easily released (Cooke, 1972). The remaining N can persist in the soil for a long period. Sluijsmans and Kolenbrander (1977) emphasizes that the direct N effect of organic matter depends much on the content of mineral N and urea. This amounts to about 10 % of the total N of FYM. The remainder of the N in FYM is of organic nature and is only gradually mineralized in the soil. Phosphorus in FYM is present largely in organic form and about half the total P present quickly becomes available to crops. In contrast to the other major nutrients, K is almost totally water-soluble and is thus readily available. According to Cooke (1972), under many circumstances 25 t /ha FYM supplies a first year crop with about 40 kg N, 20 kg P and 80 kg K. this does not provide an adequate amount of N for the uptake of most crops of average yield.

Collar diameter

Maximum gain in collar diameter was sighted in the plants under P treatment. It may be due to the fact that phosphorus is essential for cell division, cell enlargement and being a part of the cell nucleus, it is particularly important at the growing points of the plant i.e. the meristematic tissue. It promotes growth and is greatly influenced by soil pH. It has been observed often that P is more available to plants at pH 7.0. It was earlier reported that *R. serpentina* responds well to phosphates (Sahu, 1963). Similar results have been reported by Sarin (1982). Hug *et. al.* (1986) reported that the plants treated with 1000 ppm potassium naphthenate exhibited significant increase in plants height (26 %), number of leaves (36 %), leaf area (29 %), number of branches (63 %), number of inflorescence (84 %), number of fruits (75 %).

Conclusion

It can be concluded that application of fertilizers affects the growth of the plant. All the three major nutrients N, P and K must be in right proportion as their excess and deficiency leads to some disorders in the plant. Their optimum dose, thus, is to be established giving suitable balance in their internal metabolism. Each nutrient performs definite duties within the plant and none can be completely substituted for another. Although, each element performs certain specific functions, they all must work together to produce the best results. The effect of any particular nutrient on plant growth is governed by the supply of the other essential elements and hence, the effect of any one cannot be interpreted on the basis of the activities of that element alone.

In *R. serpentine*, maximum gain in height was obtained in the plants under NP treatment. It was observed that the plant responds better to chemical fertilizers than to organic manure. Maximum gain in collar diameter was sighted in the plants under P treatment. It promotes growth and is greatly influenced by soil pH. It has been observed often that P is more available to plants at pH 7.0.

References

Anon, (1986). Role of plant nutrient in crop production. In : Handbook of manures and fertilizers. ICAR. New Delhi.

Anon, (1998). Medicinal plants of M.P.- Distribution, cultivation and trade. State forest research institute, Jabalpur, 49-51.

Cooke, G.W. (1972). Fertilizing for maximum yield. Crosby Lockwood and Son Ltd. London.

Dalan, D.C. and Chrisalooper, E.P. (1949). Effect of modified fertilizer on the yield of vegetable. *Proc. Amer.Soc. Hort.* **33** : 402-406p.

Farooqi, A.A. and Sreeramu, B.S. (2001). Cultivation of medicinal and aromatic crops. 210-219.

Gupta, P. K. (2003). Handbook of soil fertilizer and manure. Agrobotanica (India), Jodhpur.

Hug, S.; Wahed Miah, M.A. and Nada, M.K. (1986). Effect of potassium naphthenate on physiological and biochemical characteristics of *R. serpentina*. *J. Sci. Ind. Res.*, **21 :** (1-4), 154-158.

Indian Pharmacopoeia List (1946). Government of India press, Calcutta, 109pp.

Lachover, D. and Arnon, I. (1966). Observations on the relationship between heavy potassium deficiency and poor quality of several agricultural products of major crops. In: Potassium and the quality of agricultural products. *Proc. 8th Cong. Int. Potash Inst.,* Bern, 439-464.

Maheshwari, S.K.; Yadav, S., Gangrade, S.K. and Trivedi, K.C. (1988). Effect of fertilizers on growth, root and alkaloid yield of Rauvolfia (*R. serpentina*). *Indian Journal of Agricultural Sciences*, **58 :** (6), 487-88.

Mathur, C.M. and Singh, S.P. (1965). Cultivation of *Rauvolfia serpentina* in Kota Forest Division (Rajasthan). *Indian Forester*, **91 :** (4), 239-242.

Mengel, K. and Kirkby, E.A. (1987). Principles of plant nutrient. 4th edition, International Potash Institute, Bern, Switzerland.

Nandi, R.P. and Chatterjee, S.K. (1975). Effect of N: P: K on growth and alkaloid formation in *Rauvolfia serpentina* Benth. Ex. Kurz. *Geobios,* **2 :** (1), 13-14.

Nayar, M.P.; Sastri and A.R.K. (1990). Red data book of Indian plants. Vol. **1**, Botanical Survey of India, Calcutta.

Piper, C.S. (1966). Soil and plant analysis. Hans Publishers, Bombay.

Russell, E.W. (1963). The individual nutrients needed by plants. In : Soil conditions and plant growth. The English language book society and Longmans green and Co Ltd. Farrold and Sons Ltd, Norwich, Great Britain.

Sahu, B.N. (1963,I) Studies on *Rauvolfia serpentina* Linn. I- Effect of farmyard manure, ammonium sulphate and superphosphate on the yield of roots of *Rauvolfia serpentina* Linn. *Proc. 56th Ind. Sci. Cong. Part I.*

Sahu, B.N. (1963,II) Studies on *Rauvolfia serpentina* Linn. II- Response of *Rauvolfia serpentina* Linn. to the application of nitrogen, phosphate and potash. *Proc. 56th Ind. Sci. Cong. Part II.*

Sahu, B.N. (1963,III) Studies on *Rauvolfia serpentina* Linn. III- Response of *Rauvolfia serpentina* Linn. to irrigation cum nitrogen and phosphate application. *Proc. 56th Ind. Sci. Cong. Part III.*

Sarin Y.K. (1982). Cultivation and utilization of *Rauvolfia serpentina* in India. In *Cultivation and utilization of medicinal plants*. Atal, C.K. and Kapur, B.M. (Eds.). Regional Research Laboratory, Jammu Tawi, Jammu & Kashmir. 288-294pp.

Sharma, P. (2001). Dravaguna Vigyan, Vol II. Chaukhambha Bharti Academy, Banaras. 36-37pp.

Shiva, A. (2002). Contribution of medicinal plants in trade: Imbalances and Prospects. In: *Recent progress in medicinal plants.* (Edt., Govil, J.N.; Pandey, J.; Shivkumar, B.G. and Singh, V.K.), Vol. **5** : 349-372.

Singh, S. and Sahi, U.P. (2005). Aushadhayia avam sagandh paudhon ke liye mrida avam poshak tatwa prabandh. *Kisan Bharti,* G.B. Pant Agricultural and technological Univ.

Pantnagar. 25-37pp. **Srivastava, N. and Kumar, S. (2003).** Drug plant resources of Doon Valley. *Ann. Of For.*, **11 :** (1), 63-84pp.

Tandon, H.L.S. and Ranganathan, V. (1976). *Fertilizers and their management in plantation crops.* Fertilizer development and consultation organization, New Delhi.

	
Fig.-1: *Rauvolfia serpentina*	**Fig.-2:Plot prepared for transplantation**
	
Fig.-3: Selected Root Trainer Seedlings	**Fig.-4: Transplanted Plot**

	
Fig.-5: Weedfree Plots	**Fig.-6: Collecting Measurements**