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RESEARCH ARTICLE

"THE EFFECTS OF VARIATION IN THE TIME OF PLANTING OF *ARTEMISIA ANNUA* ON ACCUMULATION OF ARTEMISININ CONTENT IN GOALPARA DISTRICT OF ASSAM"

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ABSTRACT

The Chinese herb *Artemisia annua* L. belong to the family Asteraceae produces artemisinin are used worldwide as drugs against malaria. Chloroquine and replacement drugs have lost effectiveness with the development of resistance and have increasingly been replaced by derivatives of artemisinin combined with other drugs known as artemisinin–based combination therapies (ACTs), they provide the most effective treatment at present. In India, interest in cultivating *Artemisia annua* resulted in emerging industrial activities demanding local biomass with high content of artemisinin to start new production chains. Several field crop experiments were carried out on the anti-malarial medicinal plant *Artemisia annua* over four cropping periods. Results were obtained after 25 months field study carried out in some areas of Goalpara district of Assam. The experiments examined the effects of variation in the time of planting and number of harvests on the yield of artemisinin and plant growth and development characters related to it. The observations showed that the artemisinin yield was positively correlated with leaf yield and number of harvests. High yields of artemisinin were realized when crop produced artemisinin-rich leaves accompanied by least possible growth of stem tissue, attained by 2 times harvesting of full grown crops.

INTRODUCTION

Artemisia annua Linn. is a very important medicinal plant and it is gaining importance as a source of drug against chloroquin (Quinine) resistant malaria and cerebral malaria. The active constituent artemisinin is an anti-malarial sesquiterpene lactone with an endoperoxide bridge and is highly effective even in drug resistant malarial parasites as well as in cerebral malaria. The essential oil of *Artemisia annua* reported to possess excellent anti-microbial, insecticidal and antioxidant properties. Artemisinin is synthesized mainly in leaves, though other green tissues of the plant also synthesize this compound. It is cultivated on a small scale in the United States as a source of material for aromatic wreaths (Janick, 1995).

The best plants are found in the wild only in certain parts of China, such as Guangxi and Hunan, which (along with Vietnam) produce most of the world's supply. Chinese scientists started to domesticate the wild species of A. annua after the curative effect of artemisinin was discovered in 1972. Production has also started in West Africa, notably Ghana and Gambia, and an extraction plant is planned for Senegal.

In Brazil, the production of *A. annua* is being promoted, while the crop has been grown in the United States and Australia on an experimental scale. *A. annua* is also collected in Eastern Europe for the extraction of essential oils for the perfume industry. The plant is increasingly grown for this purpose in such countries as Romania and Bulgaria. In India it is being cultivated on an experimental scale in temperate as well as sub-tropical conditions.

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MATERIALS AND METHODS

The study was designed to achieve overall aim of establishing *Artemisia annua* as a resistant crop in the state of Assam specially in some areas of Goalpara district. From different cultivated areas of the country 3 germplasms were collected (seeds of *Artemisia annua*), established in the nursery bed and multiplied through seedlings. The different morphological data's were collected during field experiments and fresh biomass obtained during experiments were collected after each harvest, plot-wise tagged, weighed and transported for shade drying. After drying, the leaves and stems were manually separated and weighed.

Experimental cultivation of *Artemisia annua* has cover plant research, cultivation and selection followed by laboratory tests to access the level of artemisinin produced in the plants.

RESULTS

Analysis of the collected data from four field trials

Table I Trial No -1 (T1) Goalpara (spacing 30 x 30 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (t/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves(%)	Artemisinin yield (kg/ha)
CV7	2	23.3	17.9	5.1	21	0.55	28.05
CV8	2	20.5	15.7	5.3	25	0.52	27.56
CV9	2	19.1	16.2	5.7	29	0.51	29.07
Mean		20.9	16.6	5.2	25	0.52	28.22

Trial No -2 (T2) Goalpara (spacing 45 x 45 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (t/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves(%)	Artemisinin yield (kg/ha)
CV7	2	24.8	18.7	5.8	23	0.59	34.22
CV8	2	22.4	15.9	5.2	23	0.61	31.72
CV9	2	21.6	17.1	5.5	25	0.56	30.80
Mean		22.9	17.2	5.5	23	0.53	32.24

Table II

Trial No -3 (T3) Goalpara (spacing 30 x 30 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (q/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves (%)	Artemisinin yield (kg/ha)
CV7	2	19.1	15.6	4.9	25.6	0.71	34.79
CV8	2	20.3	15.5	5.4	26.6	0.80	43.20
CV9	2	18.9	15.9	5.8	30.6	0.79	45.82
Mean	2	20.4	16.3	5.3	26.4	0.76	41.27

Trial No -4 (T4) Goalpara (spacing 45 x 45 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (q/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves(%)	Artemisinin yield (kg/ha)
CV7	2	26.6	18.6	5.5	20.6	0.79	43.45
CV8	2	24.9	15.2	5.1	27.8	0.73	37.23
CV9	2	22.1	16.8	5.4	24.4	0.81	43.74
Mean	2	24.5	16.8	5.6	24.5	0.79	41.64

Table-III

Trial No -5 (T5) Goalpara (spacing 30 x 30 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (t/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves(%)	Artemisinin yield (kg/ha)
CV7	2	23.4	17.8	5.6	23	0.52	29.12
CV8	2	20.1	14.9	5.4	25	0.56	30.24
CV9	2	19.5	16.7	5.5	28	0.53	29.15
Mean		21.0	16.4	5.5	25	0.53	29.50

Trial No -6 (T6) Goalpara (spacing 45 x 45 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (t/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves(%)	Artemisinin yield (kg/ha)
CV7	2	23.7	19.7	5.7	24	0.62	35.34
CV8	2	22.6	16.2	5.4	23	0.59	31.86
CV9	2	22.1	18.3	5.9	26	0.57	33.63
Mean		22.8	18.06	5.6	24	0.59	33.61

Table-IV Trial No -5 (T5) Goalpara (spacing 30 x 30 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (q/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves (%)	Artemisinin yield (kg/ha)
CV7	2	21.9	17.5	5.4	24.6	0.82	44.28
CV8	2	20.1	14.9	5.5	27.3	0.80	44.00
CV9	2	19.0	16.0	5.9	31.0	0.76	44.84
Mean	2	20.3	16.1	5.6	27.6	0.78	44.37

Trial No -6 (T6) Goalpara (spacing 45 x 45 cm)

Accession No.	No of harvest	Shoot mass	Stem mass	Leaf yield (q/ha)	Leaf harvest index (leaf yield × 100/shoot mass)	Artemisinin in leaves(%)	Artemisinin yield (kg/ha)
CV7	2	26.1	18.7	5.5	21.0	0.83	45.65
CV8	2	22.0	16.5	5.8	26.3	0.78	45.24
CV9	2	21.9	15.2	5.9	26.9	0.81	47.79
Mean	2	23.3	16.8	5.7	24.7	0.80	46.22

CONCLUSION

This comparative study reveals that in the 2nd field trial (TABLE-II) and 4th field trial (TABLE-IV) the artemisinin yield is higher from *Artemisia annua* crops that has been raised in the month of November by transplanting of seedlings in the field after post monsoon period in comparison of the 1st field trial (TABLE-I) and 3rd field trial (TABLE-4) which was carried out in the month of April as monsoon crop. In the both field trials the crops were harvested two times at their pre blooming stage. The spacing of 45 cm x 45 cm may be considered as the standard spacing between plant to plant which helps the growth and expansion of the plant. The comparison of results given in TABLE-I, TABLE II, TABLE-III and TABLE-IV, shows that yield differences among the crops of similar age are related to the differences in the yields of leaves and percent content of artemisinin in the leaves. It appears that artemisinin content (%) of leaves is high when harvested in April and May at the pre blooming stage.

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