Sub Project: - 5

DBT- 412

FILE No.

Prof. Arun Jagganath.

Co-PI Sheilender Goel.

Title of Project: "Exploiting..... Traits"

Name Sub-Project. 5 "Genetic..... Safflower"

Address Tenure of the Project: - 29/2/2020 to 28/2/2025

Subject Funding: - DBT

From Department: - Botany To

Record File

No. 450

FILEWELL

No. BT/Ag/Network/Safflower/2019-20
Ministry of Science & Technology
Department of Biotechnology
Government of India

Block 2, 6-8th Floors
CGO Complex, Lodhi Road,
New Delhi- 110 003
Dated: 29.02.2020

ORDER

Sanction of the President is hereby accorded, under Rule 18 of the Delegation of Financial Powers Rules ,1978 , for the implementation of the project entitled **"Exploiting Genetic Diversity for Improvement of Safflower through Genomics-Assisted Discovery of QTLs/Genes Associated with Agronomic Traits"** under mission programme of "Minor Oilseeds of Indian Origin" for a period of 5 Years at a total cost of **Rs. 195932740.00 (Rupees nineteen crore fifty nine lakh thirty two thousand seven hundred and forty only)** as per details in Para's below:

2. **The Project:**

2.1 **Title: Minor Oilseeds of Indian Origin: Exploiting Genetic Diversity for Improvement of Safflower through Genomics-Assisted Discovery of QTLs/Genes Associated with Agronomic Traits.**

2.2 Project Coordinator: Dr. A. V. Reddy, Director, IIOR, Hyderabad

2.3 Project Co-coordinator: Dr. K. Palchamy, IIOR, Hyderabad

2.4 Principal Investigators and Coordinators of the Sub-projects:

A. Sub Project – 1: Development of molecular core set of safflower (*C. tinctorius* L.) through GBS.There is one (01) component in this sub-project

i. Component-1:NBPGR, New Delhi
- PI –Dr. S. Rajkumar
- Co-PIs–Dr. J. Radhamani, Dr. R. Parimalan, Dr. Sunil Gomashe

B. Sub Project-2: GWAS for Seed Yield, Oil Content, Oil Quality And Tolerance To Biotic And Abiotic Stresses Using Molecular Core Set of Safflower Germplasm. There are 05 components in this sub-project:

i. Component-1:NBPGR, New Delhi.
- PI – Dr. S. Rajkumar
- Co-PIs -Dr. R. Parimalan, Dr. Sunil Gomashe, Dr. Sundeep Kumar, Dr. Rajesh Kumar

ii. Component-2:Indian Institute of Oilseeds Research, Hyderabad
- PI – Kadirvel Palchamy
- Co-PIs -Dr. N. Mukta, Dr. R.D. Prasad, Dr. P.S. Srinivas, Dr. PradumanYadav, Dr. Lakshmi Prayaga, Dr. P. Ratna Kumar, Dr. P. Padmavathi, Dr. M.A. Qureshi, Dr. C. Sarada

iii. Component-3: AICRP-Safflower Unit, VNMKV, Parbhani
- PI – Dr. S.B. Ghuge
- Co-PIs -Dr. PritamBhatada

iv. Component-4: AICRP-Safflower Unit, MPKV, Solapur
- PI – Dr. S.K. Shinde
- Co-PIs -Dr. S.V. Khadtare

v. Component-5: Punjab Agricultural University, Ludhiana
- PI – Dr. Pankaj Sharma
- Co-PIs -Dr. V. Kalia and Dr. Sanjula Sharma

C. Sub Project-3: Draft genome sequencing of safflower and its wild relatives. There are two (02) components in this sub-project:

i. Component-1-University of Delhi, Delhi
- PI – Prof. Arun Jagannath
- Co-PI–Prof. Shailendra Goel

Component-2:Indian Institute of Oilseeds Research, Hyderabad

- **PI –Dr. Kadirvel Palchamy**
- ***Co*-PI: Dr. C. Sarada**

D. **Sub Project-4: Development of high throughput SNP markers for genotyping applications in safflower.There are two (02) components in this sub-project:**

i. **Component-1: Indian Institute of Oilseeds Research, Hyderabad**

- **PI –Dr. Kadirvel Palchamy**
- ***Co*-PI: Dr. C. Sarada**

ii. **Component-2: University of Delhi, Delhi**

- **PI – Prof. Arun Jagannath**
- **Co-PI – Prof. Shailendra Goel**

E. **Sub Project-5: Genetic mapping of traits of agronomic value in safflower. There are two (02) components in this sub-project**

i. **Component-1: University of Delhi, Delhi**

- **PI – Prof. Arun Jagannath**
- **Co-PI – Prof. Shailendra Goel**

ii. **Component-2: Indian Institute of Oilseeds Research, Hyderabad**

- **PI –Dr. Kadirvel Palchamy**
- **Co-PI: Dr. C. Sarada & Dr. P.S. Srinivas**

F. **Sub Project-6: Development of pre-bred materials using safflower wild relatives. There are two (02) components in this sub-project:**

i. **Component-1: Indian Institute of Oilseeds Research, Hyderabad**

- **PI –Dr. Kadirvel Palchamy**
- **Co-PI: Dr. K. Anjani, Dr. P.S. Srinivas, Dr. R.D. Prasad, Dr. P. Ratnakumar**

ii. **Component-2: PAU, Ludhiana**

- **PI –Dr. Pankaj Sharma**
- **Co-PI: Dr. K. Anjani, Dr. P.S. Srinivas, Dr. R.D. Prasad, Dr. P. Ratnakumar**

2.5 Overall Objectives of the Network project:

- To develop molecular core set of safflower germplasm.
- To discover genomic regions associated with seed yield, oil content, oil quality, resistance to Fusarium wilt, charcoal rot and aphid through genome wide association studies (GWAS).
- To generate draft genome sequences of safflower (*C. tinctorius* L.) and its wild relatives, *C. oxyacantha* and *C. palaestinus*.
- To develop high-density linkage maps of safflower using Genotyping by Sequencing.
- To develop high throughput SNP markers for genotyping applications in safflower.
- To map QTLs associated with traits of agronomic value
- To develop pre-bred materials using the wild species, *C. oxyacantha* and *C. palaestinus* for exploring novel QTLs for yield components and tolerance to aphid, resistance to charcoal rot and tolerance to moisture stress.

2.6 Sub-Project/component and institutional objectives:

Overall objectives:

- To genotype entire collection of safflower germplasm (~7000 accessions) by GBS.
- To develop molecular core collection of safflower germplasm using GBS data.

A. **Sub Project – 1:**

i. **Component-1: ICAR-National Bureau of Plant Genetic Resources, New Delhi**

- To assemble entire collection of safflower germplasm available at NBPGR, New Delhi
- To purify accessions through selfing (single seed descent method)

- To, genotype entire collection of safflower germplasm available at NBPGR, NewDelhi (a single reference plant/genotype)
- To develop molecular core set through statistical analysis of GBS data

Sub Project-2:

Overall Objectives:

- To phenotype safflower molecular core set/MAGIC lines for seed yield, oil content, oil quality at multiple locations
- To screen safflower molecular core set/MAGIC lines for resistance to biotic stresses.
- To characterize and identify physiological traits associated with moisture stress tolerance in safflower germplasm.
- To screen safflower molecular core set/MAGIC lines for physiological traits under rainfed situations.
- To perform GWAS for target traits.

Component-1: ICAR-National Bureau of Plant Genetic Resources, New Delhi.

- To phenotype safflower molecular core set for seed yield, oil content, oil quality under rainfed situations.

Component-2: Indian Institute of Oilseeds Research, Hyderabad

- To phenotype safflower molecular core set for seed yield, oil content and oil quality under rainfed and situations
- To phenotype safflower core set for reaction to Fusarium wilt and aphid under artificial conditions
- To characterize and identify informative physiological traits associated with tolerance to moisture stress in safflower (to be outsourced to ICAR-NIASM)
- To evaluate safflower core set for physiological traits under moisture stress situations
- To phenotype MAGIC lines for seed yield, oil content, oil quality, resistance to Fusarium wilt and aphid for marker validation purposes

iii. **Component-3: AICRP-Safflower Unit, VNMKV, Parbhani**

- To phenotype molecular core set of safflower germplasm for seed yield, oil content, oil quality under rainfed situations.

iv. **Component-4: AICRP-Safflower Unit, MPKV, Solapur**

- To phenotype molecular core set of safflower germplasm for seed yield, oil content, oil quality under rainfed situations.

v. **Component-5: Punjab Agricultural University, Ludhiana**

- To phenotype molecular core set of safflower germplasm for seed yield, oil content, oil quality (under limited irrigated situations)
- To phenotype molecular core set of safflower germplasm for reaction to charcoal rot disease.

C. **Sub Project-3:**

Overall objectives:

- To sequence reference genotypes of C. *tinctorious*, C. *oxyacantha* and C. *palaestinus* through NGS

i. **Component-1: University of Delhi, Delhi**

- To sequence reference genotypes (parents of mapping population).

ii. **Component-2: Indian Institute of Oilseeds Research, Hyderabad**

- To sequence the most popular variety A-1 and reference genotypes of C. *oxycantha* and C.*palaestinus*

D. **Sub Project-4:**

Overall objectives:

- To re-sequence a set of reference safflower genotypes
- To develop high-density linkage maps of safflower using high throughput SNP markers.

i. **Component-1: Indian Institute of Oilseeds Research, Hyderabad**

- To re-sequence a set of reference genotypes (12)
- To genotype RIL population of the cross: CO-1 x EC-523368-2 by GBS
- To discover high throughput SNP markers in safflower
- To design KASP assays (circa 384) for SNP genotyping purposes

ii. **Component-2: University of Delhi, Delhi**

- To genotype RIL population A using GBS, SSR, AFLP and SNP markers

Sub Project-5:

Component-1: University of Delhi, Delhi

- To map QTLs associated with seed yield contributing traits, oil content and composition using RIL population A
- To develop additional populations for genetic dissection of agronomic traits distinct from those of population A

Component-2: Indian Institute of Oilseeds Research, Hyderabad

- To genotype RIL population of the cross: CO-1 x EC-523368-2 (250 lines) by GBS
- To phenotype RIL population for reaction to aphid
- To perform QTL analysis based on phenotypic data and genotypic data (GBS)

F. **Sub Project-6:**

Overall objectives:

- To develop pre-bred materials using the wild species, C. *oxyacantha* and C. *palaestinus* for agronomically important traits
- To detect novel QTLs for agronomic traits

i. **Component-1: Indian Institute of Oilseeds Research, Hyderabad**

- To characterize of wild species, C. *oxyacantha* and C. *palaestinus*, for tolerance to aphid and moisture stress 28
- To develop introgression lines from C. *oxyacantha* and C. *palaestinus*
- To detect QTLs for yield components and stress tolerance in early backcross population from interspecific crosses

ii. **Component-2: PAU, Ludhiana**

- To develop pre-bred materials using the wild species, C. *oxyacantha* and C. *palaestinus* for agronomically important traits
- To detect novel QTLs for agronomic traits

3. **Budget of the network project (Sub project wise): Details of the budget are in Annexure I.**

4. **Consolidated budget of the network project (Sub project wise) for five years:**

Name of the Institute	NR Grant	Manpower	Consu-mables	Travel	Contingency	Field & Farm	Over-head	Training	Total
Sub Project 1									
NBPGR	23.10	84.5184	360.00	2.25	1.50	16.00	3.00	0.00	**490.3684**
Sub Project 2									
NBPGR	0.00	59.52	35.00	2.00	1.00	8.00	2.00	0.00	**107.52**
IIOR	28.18	119.1888	48.00	11.00	14.00	0.00	5.00	0.00	**225.3688**
VNMKV	3.583	12.0528	17.00	1.00	1.50	12.00	1.52	0.00	**48.6558**
MPKV	2.55	12.9456	17.00	1.00	1.50	12.00	1.52	0.00	**48.5156**
PAU	0.00	50.112	10.00	0.00	0.00	15.00	2.00	0.00	**77.112**
Sub Project 3									
DU	75.99	91.8096	103.00	0.00	2.50	0.00	5.00	100.00	**378.2996**
IIOR	0.00	0.00	112.20	1.00	1.00	0.00	0.90	0.00	**115.10**
Sub Project 4									
IIOR	29.00	40.176	42.20	1.00	2.00	0.00	2.30	0.00	**116.676**
DU	0.00	0.00	23.00	0.00	2.50	0.00	1.50	0.00	**27.00**

					Sub Project 5				
	33.94	0.00	15.00	2.50	2.50	20.00	2.50	0.00	**76.44**
	12.50	39.7296	40.00	1.00	2.50	0.00	2.50	0.00	**98.2296**
					Sub Project 6				
	0.00	39.7296	10.00	0.60	0.80	0.00	1.90	0.00	**53.0296**
	11.40	50.112	13.00	0.00	2.50	17.50	2.50	0.00	**97.012**
	220.243	**599.8944**	**845.4**	**23.35**	**35.80**	**100.50**	**34.14**	**100.00**	**1959.3274**

Consolidated head Year wise budgetary details: **(Rs. in lakhs)**

Head	I year	II Year	III year	IV year	V year	Total
Non-Recurring Equipment	214.11	6.133	0.00	0.00	0.00	**220.243**
Recurring Manpower	111.408	111.408	125.6928	125.6928	125.6928	599.8944
Consumables	127.00	220.00	353.00	106.00	39.40	**845.40**
Travel	2.25	5.00	5.20	5.45	5.45	**23.35**
Contingency	4.00	4.95	8.95	8.95	8.95	**35.80**
Field & Farm	18.50	10.50	26.50	26.50	18.50	**100.50**
Travel & International Training	10.00	30.00	30.00	15.00	15.00	**100.00**
Overheads	5.80	6.09	7.50	7.50	7.25	**34.14**
Total	**493.068**	**394.081**	**556.8428**	**295.0928**	**220.2428**	**1959.3274**

i. **Head of Account:**

The expenditure for recurring is debatable to:

Demand No. 87	**Department of Biotechnology**
3425	Other Scientific Research 2019-2020
3425.60	Others (Sub Major Head)
3425.60.200	Assistance to other Scientific Bodies (Minor Head)
3425.60.200.29	Biotechnology Research and Development
3425.60.200.29.17	Assistance for Research and Development
3425.60.200.29.17.31	Grants -in-Aid General

ii. **The expenditure for Non-recurring is debatable to:**

Demand No. 87	**Department of Biotechnology**
3425	Other Scientific Research 2019-2020
3425.60	Others (Sub Major Head)
3425.60.200	Assistance to other Scientific Bodies (Minor Head)
3425.60.200.29	Biotechnology Research and Development
3425.60.200.29.17	Assistance for Research and Development
3425.60.200.29.17.35	Grants for creation of capital assets

7. **Terms & Conditions:**

i. In case the whole or a part of the amount of the grant in aid is being refunded, an interest at the rate of ten percent per annum thereon shall be recovered.

ii. The Non-recurring amount should be utilized within **18 months** from the date of Sanction Order.

iii. No Utilization Certificate is pending with the implementing Institute. All the Utilization Certificates due for rendition have been received and accepted by the head of Division/Competent Authority.

iv. A Memorandum of Agreement (MoA) will be signed between the Department of Biotechnology and the grantee institution on Non-Judicial stamp paper **Rs. 100/-** in the enclosed format and the second release/installment will be made

Annexure –I

details of the Institute/University wise sanctioned budget for the implementation of the project:

Sub Project – 1: Development of molecular core set of safflower (c. *tinctorius* l.) through GBS.

mponent-1: NBPGR, New Delhi (Rs. in lakhs)

Head	I year	II Year	III year	Total
Non-Recurring Equipment*	23.10	0.00	0.00	**23.10**
Recurring Manpower**	27.3792	27.3792	29.76	84.5184
Consumables	10.00	175.00	175.00	**360.00**
Travel	0.75	0.75	0.75	**2.25**
Contingency	0.50	0.50	0.50	**1.50**
Field & Farm	8.00	0.00	8.00	**16.00**
Overheads	1.00	1.00	1.00	**3.00**
Total	**70.7292**	**204.6292**	**215.01**	**490.3684**

*** Details of list of Equipment's:**

S. No.	Name of Equipment's	Qty	Approved Cost (lakhs)
1.	Computer Workstation with accessories	2	20.00
2.	Licensed software for genomic data analysis	1	3.10
	TOTAL		**23.10**

Details of proposed manpower:

S.No.	Name of the post	No.	I year	II Year	III year	Total
1.	JRF/SRF Rs. 31000 + 24% HRA for 1st & 2nd year Rs. 35000 + 24% HRA 3rd, year	Four	18.4512	18.4512	20.832	**57.7344**
2.	Laboratory Assistant / Technician / Project Assistant / Technical Assistant /Field Assistant Rs.20000+ 24% HRA per months	Three	8.928	8.928	8.928	**26.784**
	Total		**27.3792**	**27.3792**	**29.76**	**84.5184**

B. Sub Project-2: GWAS for Seed Yield, Oil Content, Oil Quality And Tolerance To Biotic And Abiotic Stresses Using Molecular Core Set of Safflower Germplasm.

Component-1: NBPGR, New Delhi. (Rs. in lakhs)

Head	IV year	V year	Total
Recurring Manpower*	29.76	29.76	59.52
Consumables	25.00	10.00	35.00
Travel	1.00	1.00	2.00
Contingency	0.50	0.50	1.00
Field & Farm	8.00	0.00	8.00
Overheads	1.00	1.00	2.00
Total	**65.26**	**42.26**	**107.52**

***Details of proposed manpower:**

S. No.	Name of the post	No.	IV year	V year	Total
1.	SRF Rs. 35000 + 24% HRA4th and 5th year	Four	20.832	20.832	41.664
2.	Laboratory Assistant / Technician / Project Assistant / Technical Assistant / Field Assistant Rs. 20000+ 24% HRA per months	Three	8.928	8.928	17.856
	Total		**29.76**	**29.76**	**59.52**