

severity of leaf blight (3) compared to control (7) in TG 37A. In GJG 31, pyraclostrobin + metiram and tebuconazole has reduced the severity of leaf blight (4) compared to control (7).

4. Management of leaf blight and wilt disease of groundnut occurring in western part of Rajasthan

A special programme was suggested for the management of leaf blight and wilt disease of groundnut occurring in western part of Rajasthan in the *kharif* 2018 IRC. The experiment was conducted at DGR-regional station, Bikaner. Treatments *viz.*, Tebuconazole 50%+ Trifloxystrobin 25% w/w WG (75 WG) (Nativo), Pyraclostrobin 5% + Metiram 55% (Cabrip Top), Tebuconazole 430 SC (Folicure 430SC), Carbendazim 12% + Mancozeb 63% WP (Saaf 75% WP), Propiconazole 25% EC (Tilt 25% EC), Copper oxychloride 50 WP (Blitox 50% WP) and Carbendazim 50% WP (Bavistin 50% WP) were used for foliar spray at 30 and 60 DAS. Carbendazim 50% WP (Bavistin 50% WP) and neem cake @ 200 kg/ha (approx. 500g/25 sq. M) were applied through soil application as basal. However, the disease was not developed sufficiently to evaluate the treatments.

Studies on white grub and bruchid beetle and their management in groundnut

Harish Gand Dutta R

1. Survey for collection and identification of white grub

Survey was conducted in Villages namely, Navagam, Mitapur, Kadpipadi, Semasi, Mendarda etc. of Junagadh district and white grubs were collected and sent for identification, species were identified as *Phyllognathus dionysius*, *Holotrichia serrate*, *Holotrichia* sp. and *Holotrichia reynaudi*.

2. Pesticide usage pattern in groundnut

Survey results showed that around 20 insecticides were available in market for pest management Imidicloprid was the popular sold product followed by thiamethoxam

and Coragen. Fipronil, Cypermethrin, Diafenthiuron, Novaluron, Buprofezin, Spinosad, profenocyper, phosphomidon and lambda cyhalothrin were other chemicals available in market.

3. Efficacy of Sweet flag rhizome in managing bruchid beetles

Sweet flag rhizome powder at one, two, five, ten, fifteen and twenty per cent concentration was tested for its efficacy in managing bruchid beetle along with untreated control. Observations were taken on egg laying and pod damage. Observations recorded showed that there was a significant difference among the treatments in egg laid on pods. Pods treated with twenty per cent sweet flag rhizome powder recorded lowest number of eggs (7 per





10 pods). In case of pod damage sweet flag rhizome powder of ten percent and above concentration found significantly superior and recorded 18 per cent damage as compared to 64.2 per cent damage in untreated control.

4. Seasonal incidence of insect pests of groundnut

Seasonal incidence of insect pests of groundnut was studied by sowing groundnut every month under unprotected condition. Sucking

pests were estimated using sweep net catches. Thrips and leafhoppers were found throughout the season. Highest thrips population was recorded 40 per five sweeps during 36th Standard week and leaf hopper population 88 per five sweeps was recorded during 7th standard week. Natural enemies like coccinellids and spiders were recorded during last year. Highest number of coccinellids (6) was recorded

during 30th and 48th Standard week and spiders (7) were recorded during 38th Standard week.

03 Enhancing the productivity, sustainability and resilience of groundnut based production system



Development of Climate Resilient Groundnut-based Production Systems through Precision Management Practices

Jat RA and Reddy KK

Experiment: 1. Precising row ratio and time of sowing of relay crop of pigeonpea in groundnut crop

A field experiment was conducted during *kharif* 2018 to validate suitable row ratio and timing of relay sowing of pigeonpea in bunch and semi-spreading

varieties of groundnut. The objectives of study were to maximize system productivity and profitability per unit of land and water resources, decrease cost of cultivation, enhance resource use efficiency, and sustainable intensification of groundnut based cropping systems. Two row ratios *viz.* 2:1 (R1) and 3:1 (R2) of groundnut + pigeonpea relaycropping system were allotted in main plots and three relay sowings of pigeonpea i.e. 30 (S1), 40

(S2), and 50 (S3) days after sowing of groundnut were applied in subplots. The experiment was conducted in split plot design with three replications. Two separate experiments with same set of treatments were conducted with Spanish bunch (TG 37A) and Virginia bunch (GJG 22) varieties. Groundnut varieties TG 37A and GJG 22 were sown on 21st June, 2018 at 30 x 10 cm and 45 x 10 cm spacing and harvested on 5th October and 9th October, 2018, respe



Fig. : Pigeon Pea relay sown after 30 DAS of groundnut in 2:1 (left) and 3:1 (right) ratio.



ctively. Pigeonpea variety GJP1 was relay sown after every 2 or 3 rows of groundnut as per the treatments on 23rd July, 1st August, and 10th August, 2018 which coincided 30, 40, and 50 days after sowing of groundnut. 100 percent of RDF was applied to both groundnut (25:50:30 kg ha⁻¹ NPK) and pigeonpea (25:50:00 kg ha⁻¹ NPK) through urea, SSP and MOP. Two inter-culturing operations were done at 25 and 45 DAS with mini tractor in GJG 22 and manually in TG 37A.

In Spanish bunch variety, plant height, dry matter and number of branches per plant at 75 DAS and harvest, green area index at 75 DAS, number of pegs at 75 DAS, number of immature pods per plant and their dry weight per plant at 75 DAS was recorded higher with 2:1 ratio. However, pod yield, haulm yield, hundred kernel weight, and shelling percent ($p=0.0013$) was found higher under 3:1 ratio of groundnut + pigeonpea relaycropping system. Groundnut pod equivalent yield (GPEY) was also found higher with 3:1 ratio. In case of Virginia bunch variety, plant height at 75 DAS and harvest, dry matter per plant at harvest, pegs per plant at 75 DAS, number of mature pods were found higher under 2:1 ratio.

While, weight of mature pods per plant, pod yield, haulm yield, hundred kernel weight, and shelling percent remained higher with 3:1 ratio. Groundnut pod equivalent yield (GPEY) was found higher with 3:1 ratio in both the varieties but differences were not significant.

In Spanish bunch variety, plant height at 75 DAS and harvest, dry matter per plant at 75 DAS, green area index at 75 DAS, number of immature pods and their dry weight at 75 DAS, number of mature pods and their dry weight ($p=0.008$), hundred kernel weight, shelling percent, and pod yield ($p=0.008$) was found higher with S3. However, haulm yield was recorded higher with S2 with differences being non-significant. In case of Virginia bunch variety, plant height at 75 DAS, and harvest, branches at 75 DAS and harvesting, dry matter per plant at 75 DAS, green area index at 75 DAS, pegs per plant at 75 DAS, pod yield, hundred kernel weight, and shelling percent was found higher with S1, while haulm yield was found higher with S2 with differences being non-significant. GPEY was found significantly higher with S1 in both the varieties.

Pigeonpea grain yield was recorded higher under 3:1 ratio relay sown in both Spanish and Virginia bunch varieties but differences were not significant however, stover yield was found higher under 2:1 ratio. S1 being at par with S2 was found to give significantly higher pod yield and stover yield over S3.

Experiment 2. Identifying optimum time of application of paclobutrazol in kharif groundnut

A field experiment was conducted during kharif 2018 to find out optimum time of spray of paclobutrazol in *kharif* groundnut. The treatments were: control (water spray), paclobutrazol 100 ppm at 15 DAS, paclobutrazol 100 ppm at 20 DAS, paclobutrazol 100 ppm at 25 DAS, paclobutrazol 100 ppm at 30 DAS, paclobutrazol 100 ppm at 35 DAS, paclobutrazol 100 ppm at 40 DAS. The experiment was conducted in randomized block design with three replications. Groundnut variety GJG 22 was sown on 20th June, 2018 at 45 x 10 cm spacing and harvested on 15th October, 2018.

Spray of paclobutrazol was found to significantly affect plant height at 45, 75 DAS and at harvest, branches at harvest, shelling percent and



Fig. 1: Groundnut at 75 DAS stage with control (left) and paclobutrazol @100ppm spray at 25 days after sowing.

100 kernel weight. Plant height at 45 DAS was highest with control and paclobutrazol spray at 40 DAS and lowest was with paclobutrazol spray at 20 and 25 DAS. At 75 DAS and harvest plant height was highest with control and paclobutrazol spray at 15 DAS and 35 DAS while lowest was with paclobutrazol spray at 25, 30, and 40 DAS. Branches per plant were significantly lowest with paclobutrazol spray at 15 and 20 DAS. Shelling percent and 100 kernel weight was significantly reduced when paclobutrazol was sprayed at 30, 35, 40 DAS as compared to control and spray at 15, 20, 25 DAS. Pod yield and haulm yield was produced significantly highest with paclobutrazol spray at 25 DAS and 30 DAS, respectively. While lowest pod yield and haulm

yield was produced with control.

Experiment 3. Evaluating Conservation Agriculture in groundnut+pigeonpea and groundnut+cotton cropping systems

A field experiment was conducted for consecutive fourth season during *kharif* 2018 to validate the impact of Conservation Agriculture in groundnut+pigeonpea and groundnut+cotton cropping systems in light black soils. The treatments were: four tillage practices viz. normal tillage (NT), minimum tillage (MT), zero tillage (ZT), and rota-till (RT) in main plots; two residue management practices viz. no residue (NR), and residue application (RR) in sub-plot; and two cropping systems viz. groundnut+pigeonpea (GP) and groundnut+cotton (GC) relay/intercropping systems

in sub-sub-plots. The experiment was laid out in split-split plot design with three replications. In plots having residue application treatments, pigeonpea and cotton residues were used. Groundnut and cotton was sown on 19th June, 2018 while pigeonpea was relay sown on 23rd July, 2018. Groundnut was sown with pigeonpea and cotton in 3:1 ratio. 100 percent of RDF was applied to groundnut (25:50:30 kg ha⁻¹ NPK), pigeonpea (25:50:00 kg ha⁻¹ NPK) and cotton (240:50:150 kg ha⁻¹ NPK) through urea, SSP and MOP. Groundnut and pigeonpea were harvested on 8th October and, 2018 and 18th January, 2019 respectively while in cotton last picking was done on 21st December, 2018.

Groundnut pod and haulm yield was found highest with



Fig. 1: Groundnut+pigeonpea (left) and groundnut+cotton (right) cropping systems under minimum tillage.

normal tillage (NT), while lowest pod yield and haulm yield was produced with rota tillage (RT) and zero tillage (ZT), respectively with differences being non-significant. Pigeonpea grain yield and stover yield was highest under NT and lowest was under RT with differences

being non-significant. While seed cotton yield and stalk yield was higher under minimum tillage (MT) and lowest with RT. Groundnut pod equivalent yield (GPEY) was significantly higher with NT, being at par with MT, over both ZT and RT. Groundnut pod and haulm yield

was higher when residues were removed while pigeonpea grain and stover yield, seed cotton yield and GPEY was produced higher with residue application but differences were not significant. Groundnut+ pigeonpea cropping system was found to give significantly higher groundnut pod yield, haulm yield and GPEY over groundnut+ cotton intercropping system.

Experiment 4. Re-optimization of nitrogen doses in kharif groundnut

An experiment was conducted in kharif-2018 in randomized complete block design (RCBD) having nine treatments (T1-0kg N/ha; T2-15 kg N/ha; T3-20 kg N/ha; T4-25 kg N/ha; T5-30 kg N/ha; T6- 35 kg N/ha; T7 - 40 kg N/ha; T8-45 kg N/ha;



Fig. 1: Experimental field view



T9-50 kg N/ha) and three replications to know the effect of different levels of nitrogen doses on two different groundnut varieties viz. TG37A (Spanish bunch) and GG22 (Virginia bunch) (Fig.). Pod yield increased with increasing level of N doses and highest significant yield was found at 35 kg N/ha (2013 kg/ha) and 30 kg/ha (2271 kg/ha) in GG 22 and TG37A, respectively. Haulm yield of GG-22 was not significantly affected by different treatments, while in TG 37A haulm yield was significantly high at 45 kg N/ha. Total biomass production was significantly high at 45 kg N/ha and 35 kg N/ha in TG37A (5092 kg/ha) and GG22 (4902 kg/ha) respectively. Total N uptake (kg/ha) in TG37A (451 kg/ha) and GG 22 (308 kg/ha) was found to be significantly high at 50 kg N/ha. Nodule count and fresh nodule wt. per plant in TG37A and GG 22 was found to be significantly high at 30 kg N/ha and 50 kg N/ha, respectively.

Project: 11 Management of soil and irrigation water salinity through agronomic practices in groundnut

(Meena HN and Reddy KK)
Till date: 23/6/2018

Effect of different mulching on groundnut yield under different

salinity stress

The experiment was conducted during summer 2018 to ameliorate the effect of salinity with application of different mulches under different salinity levels. The treatment consisted of four levels of salinity (0.5, 2, 4 and 6 dS m⁻¹) in main plot, three levels of mulching [without mulch (control), polythene mulch and straw mulch] in sub plot. The results revealed that significantly higher pod yield was recorded with the application of 2 dS/m saline irrigation water but significant reduction was recorded at 6 dS/m as compare to other treatments. The 60% higher pod yield was recorded at 2 dS/m as compared to 6 dS/m saline irrigation water but haulm yield of groundnut was significantly reduced at 2 dS/m and also in higher salinity levels. Further, significant differences were also recorded between types of mulching. Similar incremental effect in pod (38%) and haulm yield (14%) was observed under both type of mulching over control. Although, interaction effect of salinity x mulching revealed that as the level of saline irrigation water increases pod and haulm yield of groundnut significantly increase under polythene mulching and

straw mulching as compare to without mulching. In 6 dSm⁻¹ of irrigation water, pod yield under polythene mulch and straw mulch was 49% & 55% higher as compared to control.

Project 12: Efficient utilization of soil phosphorus in groundnut production system

Reddy KK, Jat RA and Meena HN*

*Associated till 23rd June 2018

Field experiment on application of best PSB culture using different P doses for mobilizing native soil phosphorus

The experiment was conducted in *Kharif*-2018 at DGR experimental farm (L-6) using TG37 A variety and using DAP as P Source (Plot size 5*3.6 m, spacing 30*10 cm). A total of 6 PSB (phosphate solubilizing bacteria) cultures (BHU-1, BM-1, BM, ACC-10, S-16 and BM8) were qualitatively (Pikovskaya Agar) and quantitatively (Pikovskaya Broth) estimated *in-vitro* for P solubilization (Fig. 1). BM8 culture was found to have maximum P solubilization (35.8 ppm) and it was used in field trial. The experiment consisted of 9 treatments (No P, 25% RDP, 50% RDP, 75% RDP, 100% RDP, PSB+25%RDP, PSB+50%RDP, PSB+75%RDP and PSB alone) in randomized block design with four



Fig 1: Zone of P solubilization as shown by different PSB cultures on Pikovskaya Agar

replications (Fig. 2&3). Application of PSB + 75% RDP has significantly improved groundnut drypod yield (2258 kg/ha) by 136% compared to No P control (955 kg/ha), which was at par with 100% RDP (2185 kg/ha). Total Biomass was found to be significantly high in PSB+75% RDP (4831 kg/ha), which was at par with 100% RDP (4833 kg/ha). Effect of different treatments on haulm yield and nodule dry weight were found to be non-significant.

Application of PSB+75% RDP

has also significantly improved pod yield by 12.3 % compared to 75% RDP only. PSB+75% RDP also signi

ficantly improved various growth parameters like nodule count, shoot length, root length, shoot dry weight,



Fig 2: Experimental field view

root dry weight, total biomass, shelling %, harvest index, hundred kernel weight, hundred pod weight and total plant P uptake %. It also improved various yield parameters like Hundred kernel weight, shelling &, harvest index. PSB alone treatment has significantly increased pod yield by 16% when compared to No P control. Plant P uptake (%) was significantly high in PSB+25% RDP treatment (0.78%) compared to No P (0.40%), 100% RDP treat

ment (0.46%) and PSB+75% RDP treatment (0.55%). Total P uptake (kg/ha) was significantly high in PSB + 25% RDP, which is 2.18-fold more than No-P treatment. This clearly demonstrates that the PSB improves P-uptake by plant when DAP or soluble forms of phosphorus is applied in low amounts. This suggests that PSB has effectively helped in solubilization and mobilization of native unavailable phosphorus to available forms by producing acid phosphat

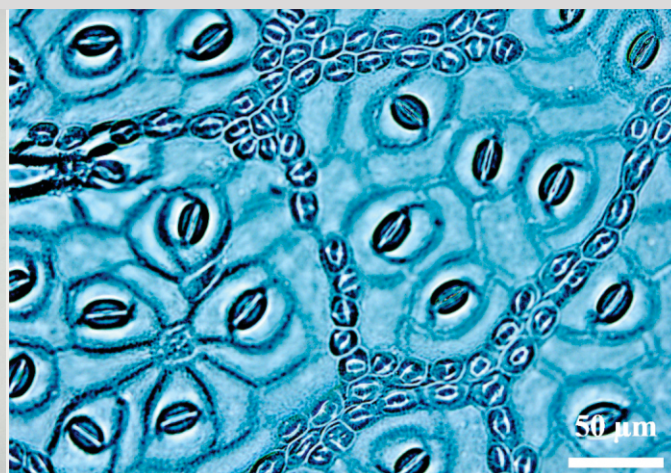
tases, alkaline phosphatases and also by reducing the rhizosphere soil pH. Soil available P at harvest improved in treatments with PSB. Application of PSB+75% RDP has significantly improved native available P (11.9 kg P/ha) compared to no P control (10.6 kg P/ha).



Fig 3: Experimental Field view

04

Biochemistry, Microbiology and physiology of groundnut in relation to plant health and nutrition, photosynthetic efficiency, nutritional quality, biotic and abiotic stress tolerance



Iron and zinc bio-fortification in groundnut

Sushmita, Singh AL, Bishi SK* and Gangadhara K

* Associated till June 2018

Zinc biofortification through Zn solubilizing microbes

Four Zn-solubilizing microbes (FP 82, FP 93, BHU-1 and BM-6) when compared with zinc sulphate (2 kg Zn /ha) in field experiment using 10 groundnut cultivars all these increased growth and pod yield of groundnut and also Fe and Zn content in the seeds. Among the Zn-solubilizers, FP 82 and FP 93 showed better response to yield and were similar to that of zinc sulphate, however all these increased the Fe and Zn contents in seed and haulm of groundnut.

Screening groundnut cultivars for high Zn and low phytic acid contents in seed

A study on Fe and Zn biofortification was undertaken in 100 groundnut cultivars by

treating these with various combinations (T₁-control, T₂-Three foliar spray of 0.5% FeSO₄ + Samriddhi + Fantac, T₃- Soil application of 50% Zn as Monzin (1kg ha⁻¹ Zn) + Three foliar spray of 0.2% ZnSO₄ + Samriddhi + Fantac) during rainy season where application of Zn increased pod yield and other parameters by controlling the over growth. The seed samples of these produce are to be analyzed for Fe and Zinc enrichments.

Seeds of groundnut cultivars, from the previous year experiments, when analyzed for Zn along with many other nutrients a wide range in the Zn and Fe concentration were observed and a few cultivars with high Zn in seed were identified (GG7, CO2 and Tirupati 3). The soil and foliar application of zinc sulphate in field caused Zn enrichment in seed both under rainfed and protected conditions.

The morphological and pod

characters for high Fe and Zn cultivars and phytic acid contents in seeds of high Zn containing cultivars are in progress. Seeds of 12 groundnut cultivars were undertaken for phytic acid analysis through Megazyme kit (K-PHYT) where phytic acid contents ranged from 0.98 to 2.65 g 100 g⁻¹. Interestingly, the cultivars having high phytic acid showed lower Zn content in their seed.

Genetics of Zn and Fe in groundnut

During *kharif* 2018, single cross was made for studying genetics of Zn and Fe in groundnut involving two parents, SG 99 and ICGV 06099. A total of 153 pods were harvested from cross between SG 99 and ICGV 06099 with success rate of 24.5%.

Zinc biofortification in groundnut using various sources of Zn

The nutrient analysis of seed of a number of groundnut



cultivars, previously grown under influence of zinc sulphate and Zn-EDTA application (soil and foliar), indicated that both of these increased the Zn content in the groundnut seed from 45-50 ppm under control to 52-64 ppm with zinc sulphate and 50-60 ppm with Zn-EDTA. There was a wide variation among the cultivars. Thus application of Zn fertilizer is must to increase Zn of groundnut seed.

Zinc and Fe biofortification through various Zn-sources

Five commercial Zn sources ie Techno Zn (15 % Zn), Monzin (33 % Zn), Tag nano zinc granules, Tag nano zinc liquid (6% chelated Zn) and Zn-Param 35 (33% Zn) were tested in a field experiment using 10 groundnut cultivars during rainy season where all these increased yield with varied responses. The seed samples of these are being analyzed for the enrichment of Zn as a result of application of different sources.

Zn and Fe biofortification in various seed-size groundnut and influence of B, Zn and Ca

The influence of B, Zn and Ca and hormone was studied on the mineral nutrition and Fe and Zn biofortification in various seed size groundnut in field taking 50 genotypes varying in their pod structure and sizes and grown at

various combination with fertilizers (T_1 -control, T_2 -Mixture of B (1 kg ha^{-1}) Ca (100 kg ha^{-1}) and Zn ($4 \text{ kg Zn as ZnSO}_4$), T_3 - T_2 + Foliar Spray of hormone Mepiquate chloride (Chamatkar @ 2.5 ml/L) and GA (Progib @ 0.20 mg/L) where a large variation in the response depending upon the seed size was observed. The organic fertilizer and Zn through Monzin was beneficial and enhanced yield. Seeds of these produce are being analysed for Fe and Zn contents.

The seeds of the produce analysed for Fe and Zn contents from the previous years experiments reveals that the seed Zn content was high in small seeded genotypes ($28\text{-}60 \text{ mg kg}^{-1}$ mean 42 mg kg^{-1}) and application of P decreased Zn in leaf, seed and shell irrespective of seed size, but Ca application increased the Zn content in all these tissues with more pronounced effects in large-size seeds. The large-size seeds require more nutrients for attaining full seed growth and high Zn in their seed. Calcium, which is essential for seed filling, increased uptake of Zn from the soil to the seeds and hence is crucial for Zn-biofortification. The cultivars with high Zn in their seed were also responsive to Ca

fertilizers. The study reveals that cultivation of high Zn-density peanut with Ca fertilizer has the potential to improve the Zn in seed.

Screening groundnut genotypes for iron-deficiency chlorosis

The screening for lime-induced iron-chlorosis (LIIC) and identification of tolerant genotypes is the regular feature of this centre in the ear-marked screening blocks where 114 advanced breeding lines (110 of Plant breeding and 4 from Cytogenetics sections) were screened for their reaction to LIIC, categorized under various classes of their tolerance and finally from these 15 were identified as tolerant to iron chlorosis during *khariif* season. Also 100 cultivars grown for Zn-biofortification were screened for LIIC, and 16 tolerant and 5 sensitive were identified.

Physiological studies in groundnut under water-deficit and salinity stresses

Singh AL, Sushmita and Bishi SK*
* Associated till June 2018

Physiological efficiencies among Indian groundnut cultivars

The 100 groundnut cultivars during *Khariif* season and 40 groundnut cultivars during *Summer* season were studied for, photosynthesis (P_N), transpiration (E), stomatal conductance (g_s), chlorophyll fluorescence, SCMR and

yields under various treatments where large variability was observed. The study identified several cultivars as high and low in P_N , E and g_s and their positive correlation with various parameters and finally pod yield.

Elasticity of tolerance to various drought situations

The screening for drought and identification of tolerant genotypes for various situations is the regular feature of this centre for the last one decade. During *kharif* season 40 recent groundnut cultivars were grown under protected (P), rainfed (RF), RF+ hydrogel as well as exposed to mid season (MSD, 50-70 DAS) and late season drought (LSD, 70-90 DAS) under ROS and their elasticity of drought tolerance were studied. Though during 2018 there was about 800 mm rainfall this was very unusual season with about 650 mm rainfall during July, 90 mm during August and only 52 mm during Sept and rest of the time crop faced drought. There was excess moisture during July, proper moisture during August, but from 15th Sept onwards the crop faced drought. The rainfed crop faced about more than 40 days of mid to end season droughts where pod and haulm yields were affected.

The yield data revealed that there was severe reduction in pod yield due to drought. However several cultivars performed well with lesser reduction in yield accordingly identified suitable for rainfed, MSD and LSD. Among the 40 a few cultivars performed well under both MSD and LSD and also a few cultivars showed most elasticity and performed well under all the 5 situations.

Pod zone moisture contents influences yield, yield attributes and aflatoxin

In a microplot study 24 groundnut cultivars, grown

pod zone (>19.6, 17.2-19.6, 15.0-17.1, 12.4-14.8, and < 12.4% moisture content) through drip. The data reveals that various groundnut cultivars, based on their phenophases, behaved differently to exposure of moisture contents in their pod zone and the moisture content below 15 % was very critical, below which drastic reduction in yield was observed. Among these seven cultivars were very sensitive showing severe yield reduction. However, 6 cultivars were most tolerant showing appreciable yield



under normal conditions were exposed to various moisture content (on dry wt basis), from 50 DAE in their

even at <15.0 % moisture content. Exposure of drought caused a few days early maturity in the cultivars with



determinate nature with more immature pods in the highly stressed crop. There was aflatoxin development in the seed of the groundnut when grown below 12.4 % soil moisture pod zone.

Water requirement of groundnut cultivars for their cultivation under drought

The 40 groundnut cultivars grown in micro-plot at only 400, 500 and 600 mm of total water distributed as per requirement of crop growth stages during cropping season behaved differently depending on their water requirement (WR) during summer season. It was observed that at 500 mm 18 cultivars, at 400 mm 16 cultivars and only 13 cultivars at 600 mm showed >2500 kg/ha pod yield and hence ideal for growing crops. Interestingly four cultivars showed maximum elasticity by performing well under all the three situations hence should be preferred for assured cultivation. There was clear cut demarcation in the Chlorophyll fluorescence and LAI (Leaf area index) recorded in these three different levels of irrigation treatments. In general the Chlorophyll fluorescence was high in the cultivars having higher photo-synthetic rate and stomatal conductance while the water sensitive cultivars showed

low chlorophyll fluorescence. The cultivars with dense canopy showed 6-7 LAI, while it was 3-5 in other cultivars.

Amelioration of drought through integrated approaches under rainfed

The drought management approaches (application of SOP (60 kg K/ha, Hydrogel at 2.5 kg ha⁻¹, and spray of succinic acid (150 ppm) and Abscisic acid (50 µM)) were evaluated by growing 10 groundnut cultivars under rainfed conditions in a field and compared with the one grown under protected conditions to minimise the yield losses. The crop faced droughts from 10th Sept onward causing sufficient reduction in pod yield under rainfed. The study reveals only a mild effect of these ameliorant on increasing pod yield and none of these treatment could increase pod yield in groundnut under rainfed conditions. However effect of these treatments varied with cultivars and SOP increase pod yield of Kadiri 9 and Hydrogel increased pod yield of GJG 13 and GPBD 4 under rainfed.

Influence of growth regulators on seed size

The commercial growth regulators Lihocine (Chloromequate chloride), Planofix (Alpha Nephthyl Acetic acid),

Chamatkar (Mepiquate chloride), Progibb (GA) and Herbo-zymes applied as foliar spray (thrice at 40, 60 and 75 DAS) arrested growth and increased pod yields, seed size and germination of two groundnut GG 7 and TG 37 cultivars and hence recommended.

Studied on soil salinity tolerance mechanism

In a salt treated screening block, 57 groundnut cultivars were grown at two (2 dS m⁻¹ and 4 dS m⁻¹) salinity levels and based on germination, plant survival, and yield attributes five cultivars showing comparatively high tolerance with reasonable pod yield at 4 dS m⁻¹ were recommended for their cultivation. The higher salinity decreased most of the physiological parameters (photosynthesis, transpiration and stomatal conductance) resulting in low yield.

Physiological studies in groundnut under water-deficit and salinity stresses

The effect of water deficit and salinity stress was studied in various groundnut cultivars by recording Chlorophyll fluorescence, RWC, SLA, membrane stability index and lipid peroxidation. In general, Chlorophyll Fluorescence, RWC and SLA of leaves declined during water deficit as well as salinity



stress. The water stressed plants showed lower membrane stability index (65-76) indicating leaky membrane which ultimately increased lipid peroxidation (MDA content of the membrane).

Impact of heat stress on groundnut metabolism and quality

Bishi SK, Mahatma MK, Singh AL and Sushmita

Forty groundnut cultivars (19 spanish and 21 virginia) were undertaken for a field experiment wherein staggered date of sowing was done with 20 days interval between each date of sowing (D1: 21st Jan; D2: 10th Feb; D3: 2nd March). This was done to expose the cultivars to different temperature conditions at their flowering time and characterize them for thermo-tolerance. The second date of sowing coincides with the normal date of sowing for groundnut crop.

Salient Findings:

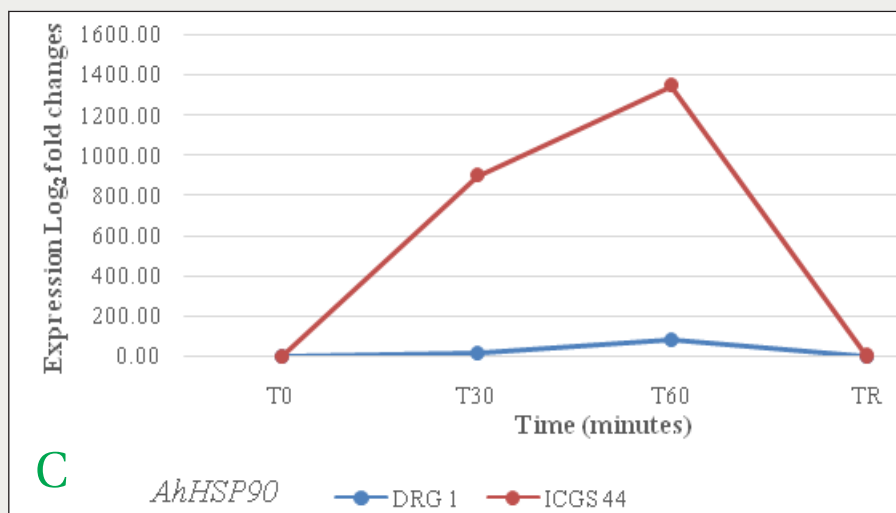
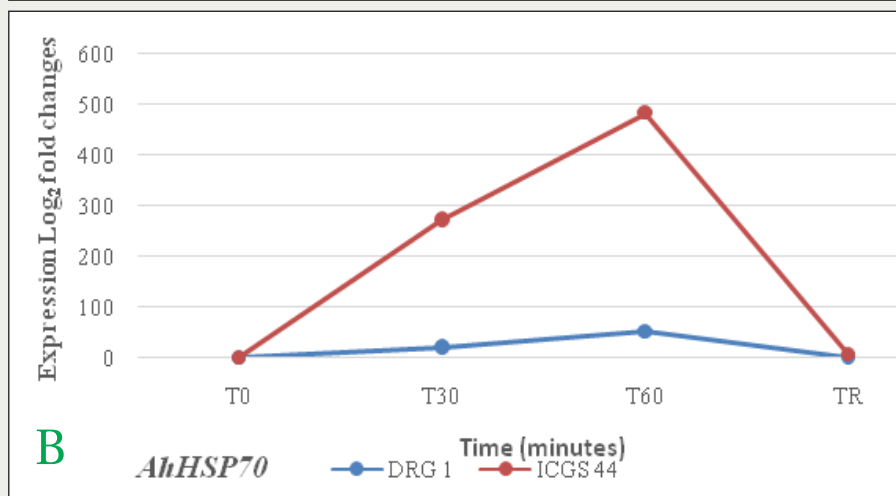
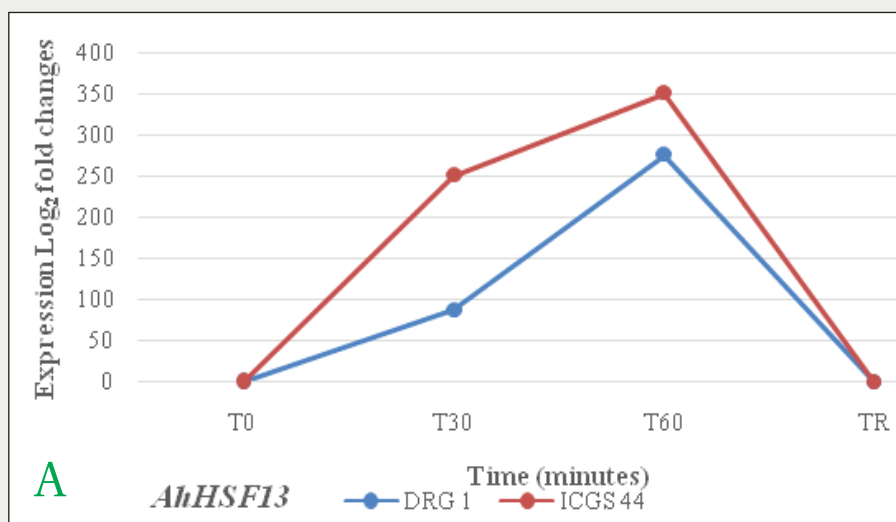
1. The Physiological observations for different temperature regimes varied considerably with a marked reduction in photosynthetic rate, relative water content, membrane stability index (MSI) and chlorophyll fluorescence values. The treatment D3 was found to have more severe impact on all these parameters with membrane stability values showing 40-52% and chlorophyll fluorescence

(quantum efficiency, Fv/Fm) values 0.57-0.65. Among the cultivars, ICGS 44 was found to be relatively tolerant and was recorded to have higher values for chlorophyll fluorescence (Fv/Fm: 0.65) and MSI (52%) whereas susceptible cultivars like DRG 1 showed minimum values for MSI (41%) and chlorophyll fluorescence (0.56). These physiological aspects can therefore be crucial to impart thermo-tolerance attributes to the cultivars. The crop phenology was found to be shortened for all the cultivars displayed shortened with earliness in flowering as well as reduction in number of days to attain physiological maturity under late sown condition (D3).

2. Heat shock transcription factors (HSFs) play a crucial role in plants response to several abiotic stresses especially heat stress (HS) by regulating the expression of stress-responsive genes, such as heat shock proteins (HSPs). The role of plant HSFs in heat stress (HS), has been recently brought to light. In a recent study, Wang et al (2017) identified 16 and 17 HSF genes from *Arachis duranensis* and *A. ipaensis*, respectively and studied their temporal and spatial expression under HS (42°C). From the study, it was observed that *AhHSF4*, 5, 6,

10, 11, and 13 could response rapidly to high temperature, and up-regulated after 1 h treatment. In the present study, we carried out the expression analysis of few of the above HSFs and HSPs (*AhHSP70* and *AhHSP90*) using two genotypes (identified in our earlier experiments), ICGS 44 (tolerant) and DRG 1 (susceptible). The seeds were grown in controlled conditions in P-II glass house with mean day-night temperature 35/25 °C and mean relative humidity 40/60 %. The 7 days old plants were exposed to HS i.e. 42 °C in a seed germinator with light and humidity control. The leaf tissues were collected after different time intervals (0, 30 and 60 min) for RNA isolation to study the kinetics of *AhHSF13*, *AhHSP70* and *AhHSP90* gene. Sample harvested from unstressed plant was used as control (C). Further, to study the recovery after HS, tissues were collected from plants exposed to 1 hr HS and kept at 25 °C overnight.

The gene expression analysis showed that *AhHSF13* induced within 1 min after HS treatment. To check the expression status of *AhHSF13*, *AhHSP70* and *AhHSP90*, it was revealed that all these genes showed similar expression pattern only differing in their magnitude. The



Gene expression pattern of *AhHSF13*, *AhHSP70* and *AhHSP90* in contrasting groundnut genotypes in response to heat stress.

The time-course induction pattern of A. *AhHSF13*, B. *AhHSP70* and C. *AhHSP90* by exposing seven days old seedlings to 42°C in the groundnut genotypes DRG 1 (susceptible) and ICGS 44 (tolerant) using qRT PCR.



tolerant genotype, ICGS44 maintained a higher induction of all these genes at any point of time than that of the susceptible genotype, DRG1. The gene expression pattern in the HS recovered plants also showed similar pattern of expression as that of control plants suggesting their roles only on exposure to HS.

In future, further characterization of *AhHSF13* and detailed expression analysis of HSPs and other downstream genes need to be carried out to confirm its role in HS tolerance in groundnut.

Evaluation of nutritional and bioactive compounds of groundnut

Mahatma MK, Bishi SK, Rathnakumar AL, Singh AL*

* Associated till 23rd June 2018

Experiment-1: Estimation of phenolics and mineral content in groundnut cultivars

Total 16 phenolics viz., caffeic acid, catechol, chlorogenic acid, cinnamic acid, coumaric acid, ferulic acid, gallic acid, syringic acid, salicylic acid, vanillic acid, catechin, epicatechin, epigallocatechin, kaempferol, resveratrol and quercetin were identified in groundnut kernel using LC-MS/MS. These phenolics were identified based on retention time and mass value of

standard phenolics. Cinnamic acid, syringic acid, catechol, kaempferol and catechin are predominant phenolics in groundnut kernels. Highest cinnamic acid was observed in ICGV-91114 (24.91 $\mu\text{g}^{-1}\text{g}$) followed by Kadiri 6 (21.33 $\mu\text{g}^{-1}\text{g}$) and TAG 24 (20.24 $\mu\text{g}^{-1}\text{g}$) while minimum in GG5 (1.45 $\mu\text{g}^{-1}\text{g}$). Less genotypic variation was observed for kaempferol, catechol, salicylic acid and quercetin. Resveratrol is a naturally occurring stilbene that is present in red wine grapes varieties (19 to 508 $\mu\text{g}^{-1}\text{g skin}$); red wine (0.6-8.0-1 $\mu\text{g}^{-1}\text{mL}$) blueberries (32 ng^{-1}g) is also found in groundnut at different levels. AK159 had lowest resveratrol content (0.47 $\mu\text{g}^{-1}\text{g}$) while highest in GG7 (7.13 $\mu\text{g}^{-1}\text{g}$) followed by TAG 24 (4.54 $\mu\text{g}^{-1}\text{g}$) and GG20 (2.93 $\mu\text{g}^{-1}\text{g}$). Resveratrol content was observed more than 2 $\mu\text{g}^{-1}\text{g}$ in GG5, TAG39, Kadiri 6 and GG18. Mineral content in kernels of 31 groundnut cultivars were analysed. Iron content was observed in the range of 3.6-8.9 $\text{g}^{-1} 100\text{g}$ in Kadiri 9 and TG 51. TG 51, Kadiri 7 and GJG 22 have more than 8.0 $\text{g}^{-1} 100\text{g}$ Fe content. Average Zn content in groundnuts cultivars was 3.1 $\text{g}^{-1} 100\text{g}$ with a range from 24-47 $\text{g}/100\text{g}$. Highest Zn content was observed in JL 776 (4.7 $\text{g}^{-1} 100\text{g}$) followed by GG7 (4.3 $\text{g}/100\text{g}$) and TG26

(4.0 $\text{g}^{-1} 100\text{g}$). Wide variation for Ca content was observed in groundnut cultivars, which ranged from 12.8 $\text{g}/100\text{g}$ (TKG 19A) to 63.3 $\text{g}^{-1} 100\text{g}$ (GJG 22). Groundnut is a good source of K which ranged from 422 $\text{g}^{-1} 100\text{g}$ (BAU13) to 602 $\text{g}^{-1} 100\text{g}$ (Kadiri 7).

Experiment-2: Effect of roasting on nutritional quality traits of groundnut genotypes

Groundnut kernels of 31 cultivars were roasted in oven at 140° C. Nutritional quality traits of roasted kernels was analysed. Though, moisture content was decreased in all the analysed cultivars from 0.8% (GJG 22) to 4.5% (BAU 13). Oil content was increased in 17 cultivars while decreased in 14 cultivars after roasting. An inverse relationship was observed for protein content, which was decreased in 17 cultivars where oil content was increased and decreased in 14 cultivars where oil content was decreased. Total phenol content was decreased in all genotypes after roasting from 13.7% (GJG18) to 50.9% (TLG45) with an average decrease of 35.3%. Free amino acid content of groundnut kernel increased in all cultivars after roasting in the range of 10 (TG26) to 155% (AK159) compared to their raw kernels. Results of sugar profiles revealed that total sugar content was



Table: MRM of mixture of 15 polyphenol standards in ESI positive mode
*MRM of Resveratrol in ESI negative mode
Multiple reaction monitoring (MRM)

Name of the std	MRM transition		MRM retention time (min)
	Parent ion	Daughter ion	
Gallic acid	168.91	124.82	1.180
Epigallocatechin	305.06	124.82	1.990
Catechin	289.07	108.84	2.080
Catechol	108.89	107.80	2.110
Chlorogenic acid	353.12	190.11	2.300
Caffeic acid	178.95	134.83	2.665
Vanillic acid	166.95	107.81	2.705
Epicatechin	289.08	122.82	2.730
Syringic acid	197.00	122.80	2.885
Coumaric acid	162.94	118.84	3.440
Ferulic acid	192.97	133.85	3.710
Salicylic acid	137.92	93.82	4.470
Quercetin	301.03	150.81	5.710
Cinnamic acid	146.93	76.79	5.800
Kaempfero	1285.03	92.81	6.295
Resveratrol*	229.18	106.89	4.470

increased after roasting in most of cultivars it was increased except Girnar 2 and GG 20 in which it was decreased 4.8% and 14.11. Sucrose content was also increased after roasting except Girnar 2 and GG 20. While, raffinose a flatus sugar was decreased in 18 cultivars. Fatty acids also altered after roasting of groundnut kernels. Palmitic acid increased from 0.20 to 2.3% with an

average of 0.44% in all cultivars. While oleic and linoleic acid decreased in about 20 cultivars. Phenolic acid profiles of twenty cultivars was carried out using LC-MS/MS. Results showed that gallic acid, ferulic acid, chlorogenic acid, catechin, epicatechin and resveratrol content were increased in JL501, BAU13 and OG52-1. Coumaric acid was increased only in Girnar

2 and JL501. Cultivars which possess low content of resveratrol in raw kernels, it was increased after roasting while cultivars possess higher content, it was decreased after roasting. Resveratrol content was found higher in raw kernels of GG7 (7.5 $\mu\text{g}^{-1}\text{g}$), TAG 24 (4.6 $\mu\text{g}^{-1}\text{g}$), GG20 (2.9 $\mu\text{g}^{-1}\text{g}$), GG5 (2.6 $\mu\text{g}^{-1}\text{g}$), TG 39 (2.4 $\mu\text{g}^{-1}\text{g}$). While, after roasting resveratrol content was found



higher in GJG18 ($4.3 \mu\text{g}^{-1}\text{g}$), JL 501, BAU13 ($2.5 \mu\text{g}^{-1}\text{g}$), Girnar 3 and GG20 ($2.3 \mu\text{g}^{-1}\text{g}$). Antioxidant activity was decreased in all most all cultivars after roasting, Mineral contents were also altered after roasting, but a distinct trend was not observed. Overall, these results showed that roasting alters the quality traits of groundnut kernels but increase or decrease after roasting is cultivar dependent.

SERVICES:

Oil, protein and moisture content of 4600 groundnut samples from different section of DGR and AICRP-G centers were measured by NIR spectroscopy.

Studies on microorganisms in relation to plant health and nutrition in groundnut

Dey R, Pal KK and Thirumalaisamy PP

A. Development of liquid formulation of DAPG-producing fluorescent pseudomonads

Formulations of DAPG-producing *Pseudomonas putida* DAPG4, which has been recommended for enhancing growth, yield and nutrient uptake in groundnut due to development of suppressive soils for management of stem and collar rot diseases of

groundnut, were developed in different combinations. The formulations were inoculated with the concentrated culture suspension of 1.5×10^{12} cfu/ml and population built-up and shelf-life was monitored at 0h, 3d, 5d, 15d, 30d, 45d, 60d, 90d, 120d, 150d, 180d, 210d, 240d, 270d, 300d, 330d and 360 days after inoculation in eight different combinations. The population of DAPG4 in the eight different liquid formulations stored in room temperature was

monitored upto 1 year. The bacterial population dropped at 15 days after inoculation, and after 6 months the population declined sharply. After 9 months of inoculation and storage at room temperature, the culture was viable in formulation 4 and 8 only. The population count in formulation 4 and 8 was 1.76×10^8 and 4.2×10^8 cfu, respectively after storage in room temperature for 1 year. Thus, these two liquid formulations of DAPG 4 can be

Table 1. Evaluation of competitive strains of groundnut rhizobia for enhancing BNF and yield of groundnut (cv TG37A) during Summer 2018

Treatment	PY (kg/ha)	NN/p
Control	2065	17.1
TAL1000	1952	20.5
Rhi23	2073	19.8
Rhi24	2396	31.2
Rhi25	2340	28.0
Rhi11	2237	25.5
Rhi19	2226	25.4
Rhi35	2423	29.1
Rhi26	2114	21.8
Rhi10	2487	33.1
Rhi17	2224	21.3
Rhi18	2084	24.4
Rhi20	2343	30.8
CD (0.05)	225	6.3



used for preparing, storage and application of DAPG 4 bioinoculant.

B. Evaluation of competitive strains of groundnut rhizobia for enhancing BNF and yield in groundnut

Eleven efficient and competitive strains of groundnut rhizobia, including a standard culture TAL1000, were evaluated in a field trial with cultivar TG37A during the summer season, to assess the effects of their inoculation on the growth and yield of groundnut. Seed inoculation with 5 of the isolates resulted in significant enhancement of yield (13 – 20%). These isolates also resulted in increase in haulm yield, shelling out-turn and nodulation (Table 1).

C. Studying the diversity of groundnut rhizobia in the Saurashtra region of Gujarat

A total of 61 rhizobial isolates were obtained from nodule samples collected from different groundnut germplasm and cultivars. The isolates will be characterized and identified by 16S rRNA sequencing before further evaluation.

D. Characterisation of epiphytic bacteria and their selection

Phyllosphere or epiphytic bacteria can be used as potential biological control agents for air-borne fungal pathogens. Forty-eight morphologically different isolates of epiphytic bacteria were selected for studying their antifungal activities against two major foliar pathogens of groundnut, i.e. *Alternaria* and LLS pathogen. Though 19 cultures showed antifungal activities against *Alternaria* (3-18 mm inhibition zone after 96 h of incubation), six isolates were promising in showing high degree of antifungal activity

against *Alternaria* (>10 mm inhibition zone). Nine epiphytes showed antifungal activities against LLS pathogen, the inhibition zones ranging from 6 to 12 mm.

B. Characterization of Zn, K, and Mn solubilising microorganisms and quantitative estimations Zn solubilisation:

The PGPR cultures BHU-1, FP82, BM6, FP93 and *Bacillus megaterium* have been identified as efficient Zn solubilizers. The quantitative estimation of Zn solubilised by these cultures was carried out under in vitro conditions, using three insoluble sources of Zn, i.e., zinc oxide, zinc phosphate, and zinc carbonate. All the 5 cultures were able to solubilise insoluble zinc compounds as evident from the amount of soluble zinc available in the broth and drop in pH. Among the three insoluble sources of zinc,

Table 2. Solubilization of different forms of zinc by different isolates of PGPR

Isolate	ZnO		Zn ₃ (PO ₄) ₂		ZnCO ₃	
	Zn (ppm)	pH	Zn (ppm)	pH	Zn (ppm)	pH
FP82	2.26(±0.14)	6.33(±0.07)	7.92(±0.70)	4.87(±0.12)	1.10(±0.12)	5.54(±0.09)
BHU1	1.96(±0.37)	5.92(±0.03)	7.40(±0.91)	6.69(±0.01)	1.09(±0.06)	4.75 (±0.13)
BM6	1.81(±0.26)	6.58(±0.09)	6.96(±0.98)	6.46(±0.12)	1.78(±0.32)	4.66 (±0.13)
FP93	1.96(±0.06)	6.60(±0.05)	8.22(±0.96)	5.01(±0.20)	2.30(±0.34)	6.63 (±0.01)
B. megaterium	ND	ND	7.05(±0.69)	4.94(±0.27)	0.28(±0.08)	6.55(±0.01)

ND= not detected; data in the parenthesis represent standard deviation from mean

Table 3. In vitro solubilization of potassium aluminosilicate by different PGPR and DAPG-producing fluorescent pseudomonads

Treatments	K (ppm)	pH
Control	2.40 (±0.20)	7.49 (±0.04)
DAPG1	21.20 (±0.61)	6.39(±0.02)
DAPG2	24.10 (±1.04)	6.10(±0.22)
DAPG3	21.93 (±1.86)	6.16(±0.33)
DAPG4	19.13 (±1.40)	6.48(±0.18)
DAPG5	21.93 (±1.32)	6.34(±0.32)
DAPG6	23.57 (±1.91)	6.31(±0.09)
DAPG7	23.83 (±1.29)	6.11(±0.13)
FP 46	28.30 (±0.70)	6.27(±0.13)
FP 82	26.43 (±1.16)	6.21(±0.26)
FP 86	26.37 (±0.78)	6.39(±0.19)
FP 93	14.30 (±1.90)	5.44(±0.18)
FP 121	14.50 (±1.39)	4.96(±0.16)
FP 133	12.63 (±1.07)	5.18(±0.26)
BHU 1	12.57 (±0.72)	5.00(±0.21)
S 16	16.10 (±0.79)	5.39(±0.21)
BM 6	17.70 (±0.53)	4.83(±0.10)
NC 92	14.07 (±2.08)	5.39(±0.34)
ACC 3	19.63 (±0.91)	5.16(±0.08)
C 185	8.60 (±0.60)	5.27(±0.09)
B mega	12.70 (±1.11)	5.44(±0.07)
ACC 10	9.23 (±1.08)	4.98(±0.06)
SEN 15	17.73 (±1.93)	6.38(±0.09)
J 22	18.30 (±2.00)	5.51(±0.31)
SEN 29	14.07 (±1.50)	5.60(±0.05)
J 20	6.00 (±0.26)	6.75(±0.08)

Data in the parenthesis represent standard deviation from mean

zinc phosphate was solubilised the maximum (Table 2). The cultures FP82 and FP93 were more efficient Zn solubilizers.

The solubilisation of insoluble zinc into soluble forms was due to the production of organic acids. The profile of organic acids secreted by different organisms during

solubilisation of different forms of zinc was studied by HPLC. Different organic acids like malic, citric, succinic, propionic, oxalic, malonic acid, etc. were secreted by the zinc solubilising microorganisms. Malic acid was found to be a major organic acid secreted during the process.

Ksolubilization:

Twenty-five PGPR cultures showed clear zones of K solubilization in petridishes, using potassium aluminosilicate as insoluble source of K. These K-solubilizing bacterial cultures were tested under in vitro conditions for quantification of K-solubilization using potassium aluminosilicate as insoluble source of potassium. All the isolates solubilised K (6–28 ppm) with decrease in pH (4.8–6.75). All the DAPG-producing fluorescent pseudomonads were efficient K-solubilizers. The profile of organic acids secreted by K-solubilizing bacteria during K-solubilization in vitro was studied by HPLC. The organic acids like oxalic, malic, malonic, citric, succinic and propionic could be detected in the culture filtrate, oxalic and succinic being the major organic acids.

Mn solubilisation:

Around 30 tentative Mn solubilising isolates have been obtained and the qualitative method for solubilisation studies are underway.



Application of microorganisms for management of biotic and abiotic stresses in groundnut

Pal KK, Dey R, Meena HN*, Mahatma MK, Harish G, Ajay BC, Narayanan G and Reddy KK**

*Upto June 2018; ** from January 2019

A. Evaluation of role of different endophytes for alleviation of drought stress and saving of irrigation water and mechanisms of alleviation (Summer 2018)

To ascertain whether substantial irrigation water can be saved by application of endophytic bacteria in summer groundnut, it was found that application of endophytes and 5 irrigations can provide as much pod

yield (average 2604 kg/ha) that can be obtained with 10 supplementary irrigations after emergence (2494 kg/ha) without endophytes. Inoculation of endophytes improved the pod and haulm yield of groundnut at all level of irrigations (Table 1). Maximum benefit was provided by *Bacillus firmus* J22, followed by *Acinetobacter junii* J20.

Thus, it would be feasible to reduce quantity (30-50%) and frequency of irrigations (4-5 irrigations) substantially for raising summer groundnut with endophytes and there is possibility of horizontal spread in areas with the application of endophytes with the available quantity of irrigation water.

A separate experiment was also conducted to ascertain the role of endophytes in alleviation of drought stress with two supplementary irrigations after emergence (50 DAE and 75 DAE) with cultivar TG37A. It was found that there was improvement in yield of groundnut by 16-26% due to inoculation of endophytes (Table 2). Maximum benefit was accrued due to inoculation of *Bacillus firmus* J22.

The modulation of C3-CAM transition was also studied and it was found that there was enhanced level of production of key enzymes of carboxylation and de-carboxylation modules of C3-CAM pathways due to inoculation

Table 1. Interactive effects of irrigation and endophytes on pod yield (kg/ha) of groundnut (Summer 2018; TG37A)

Treatments	No of supplementary irrigations				Mean
	3	4	5	10	
Control	1602	2173	2321	2494	2147
REN47	1739	2296	2604	2586	2306
SEN29	1957	2305	2549	2535	2337
J20	1738	2270	2664	2497	2292
R51	1782	2390	2663	2660	2374
J22	1777	2273	2543	2591	2296
Mean	1766	2285	2557	2561	2292
	LSD (0.05)				
Treatment	90				
Irrigation	63				
Treatment X Irrigation	153				

Table 2. Application of endophytes for alleviation of drought stress in groundnut (cv TG37A), Summer 2018 (2 irrigations after emergence)

Treatments	PY (kg/ha)	HY (kg/ha)	% increase over control
Control	1668	3203	-
J20	1997	3433	19.7
J22	2103	3877	26.1
R47	1908	3743	14.4
R51	1941	3787	16.4
SEN29	1958	3707	17.4
CD (0.05)	213	396	-

of endophytes in groundnut during the period of drought stress in different treatments.

B. Evaluation of endophytes for alleviation of salinity stress in groundnut and mechanisms of alleviation

Five endophytes (*Bacillus firmus* J22, *Bacillus subtilis* REN51, *Pseudomonas pseudoalcaligenes* SEN29, *Acinetobacter junii* J20 and *Pseudoxanthomonas mexicana* REN47) were evaluated during summer 2018 with cultivar TG37A for alleviation of salinity stress, if any and with salinity level of around 4.8 at harvest. Results indicated that there was drastic reduction in yield of groundnut with the application of saline water, and at around 4.87 EC of soil salinity at harvest. However, application of endophytes like *Bacillus firmus* J22, *Pseudoxanthomonas mexicana* REN47 and *Bacillus subtilis* REN 51 prevented the reduc-

tion in yield losses by improving the yield by 10%, 14%, and 11%, respectively (1566 kg/ha in control and 1724-1793 kg/ha with these endophytes) at soil EC of around 4.87 at harvest (Table 3). Attempt was made to understand whether there was modulation in the C3-CAM transition in salinity stress alleviation by these endophytes also, besides enhanced production of ROS scavenging enzymes for detoxification of reactive oxygen species. To do so, it was required first to understand whether C3-CAM transition occurs in cultivated groundnut under salinity stress.

However, as C3-CAM transition in salinity stress in cultivated agricultural crop has not been reported yet, a separate experiment was undertaken with TG37A and two of its C3-CAM transited and drought tolerant variants

with soil salinity level of around 4.87 at harvest to understand the phenomenon further. Salinity was developed by application of NaCl:Na₂SO₄:MgSO₄:CaCl₂ @ 6:4:2:1 ratio. It was found that while development of salinity at 4.87 of soil EC at harvest reduced the biomass production in the cultivar TG37A by almost 48% (7300 kg/ha in normal soil condition to 3786 kg/ha in around 4.2 soil EC in TG37A), the over-expressive C3-CAM transited variants of TG37A (which are otherwise drought tolerant) like DGRMB5 minimized the biomass reduction (5736 kg/ha) and maintained at 25% level of reduction (Table 4). Studying the expression of key enzymes of modules of C3-CAM transition indicated the over-expression of CA, PEPC, MDH, NAD(P)-ME, PPDK, VATPase, etc. many fold in carboxylation and decarboxylation modules in leaf with inverse stomatal behaviour which began at around 4.0 EC of soil salinity. Night-time carboxylation and day-time decarboxylation were observed.

C. Evaluation of endophytes for alleviation of salinity stress in groundnut at Madvi, Bhuj (Collaborator, Dr. S. Acharya, CSSI, Mandvi)

Three endophytes *Bacillus firmus* J22, *Bacillus subtilis*



Table 3. Effect of endophytes in alleviation of salinity stress in groundnut (cv TG37A) during summer 2018 (Soil EC at harvest: 4.87)

Treatments	PY (kg/ha)	HY (kg/ha)	% reduction in yield	% reduction in biomass
Control	1566	3420		
J20	1706	3700	8.94	8.42
J22	1724	3570	10.11	6.18
R47	1793	3793	14.50	12.04
R51	1737	3900	10.92	13.06
SEN29	1518	3677	-3.09	4.18
CD (0.05)	137	242		

Table 4. Biomass production under salinity stress (average soil EC at harvest: 4.87 in salinity treatment)

Treatments	Pod yield (kg/ha)			Haulm yield (kg/ha)			% reduction in yield	% reduction in biomass
	1	2	Grand Total	1	2	Grand Total		
DGRMB19	3457	1814	2635	4037	3200	3618	47.53	20.73
DGRMB5	3399	2173	2786	3860	3563	3712	36.07	7.68
TG37A	2590	1489	2040	4710	3630	4170	42.50	22.93
Grand Total	3149	1825	2487	4202	3464	3833		
LSD (0.05)								
Treatments	171			218				
Salinity	113			217				
T X S	195			376				

R51 and *Pseudomonas pseudoalcaligenes* SEN29 were evaluated in two separate experiments, one with cultivar GG2 with flat bed and broad bed whereas in 2nd experiments, these endophytes were evaluated with four Spanish bunch varieties GG2, GG5, GG7, and TG37A. The treatments differences for pod yield were significant mainly due to

significant differences among microbes and Land Configurations x Microbes x FYM. Among microbes, J22 was the best giving significantly and 80 and 23 per cent higher pod yield (846 kg/ha) than the mean pod yield with no microbes (471 kg/ha) and SEN 29 and R 51 (691 kg/ha each), respectively. Land configurations evinced no difference; though flat bed

with FYM gave the highest yield (724 kg/ha). The Land Configurations X Microbes x FYM interaction term was significant. Therefore, it would be worthwhile to select their specific combinations for higher pod yield. J22 in combination with FYM gave significantly and 128 and 81 per cent higher pod yield under flat bed (1073 kg/ha) and raised bed (853

Table 5. Impact of application of endophytes on yield of different genotypes under irrigated condition (saline water, Mandvi, Bhuj, kharif 2018)

Treatments	Endophytes				
	J22	SEN29	R51	Control	Mean
GG2	1833	1503	2479	2000	1954
GG5	2176	2409	2118	1920	2156
GG7	2433	1908	2021	1460	1955
TG37A	1572	2027	1397	1270	1567
Mean	2003	1962	2004	1663	1908
SE _m ± (Genotypes)		135.2	CD 5% ± (Genotypes)		390.5
SE _m ± (Endophytes)		135.2	CD 5% ± (Endophytes)		NS
SE _m ± (Genotypes x Endophytes)		270.4	CD 5% ± (Geno x Endophytes)		NS

kg/ha) than mean pod yield with no microbes' application (471 kg/ha), respectively. All the microbes' combinations, irrespective of FYM application or land configurations (except SEN 29 with no FYM application) gave significantly higher yield than the mean performance under no microbes' application (471 kg/ha). J 22 in combination with FYM was the best both under flatbed (1073 kg/ha) and raised bed (853 kg/ha) evincing 128 and 81 per cent higher pod yield than mean pod yield with no microbes' application (471 kg/ha).

In the 2nd experiment, there were significant differences among the genotypes for pod yield. GG 5 gave significantly and 38 per cent higher pod yield (2156 kg/ha) than TG37A (1567 kg/ha) but was at par with GG2 (1954 kg/ha)

and GG7 (1955 kg/ha) (Table 5). Further, GG2 and GG7 were at par with TG37A. The endophytic strains did not differ significantly, though numerically J22, R51 and SEN29 out yielded control (1663 kg/ha) by 20, 20 and 18 per cent, respectively.

D. Evaluation of C3-CAM transited variants of TG37A

A total of seven drought tolerant variants of TG37A (DGRMB3, DGRMB5, DGRMB13, DGRMB17, DGRMB19, DGRMB29 and DGRMB31) were evaluated alongside TG37A with two levels of irrigations, two and full (10), after emergence. It was found that whereas reduction of biomass was around 42% in TG37A with two supplementary irrigations, C3-CAM transited variants showed biomass reduction from 25-32% in similar conditions. Least

reduction in biomass was obtained with DGRMB5. In case of pod yield, reduction was around 49% in TG37A with two irrigations whereas it varied from 32% to 40% in different CAM variants (Table 6).

During kharif 2019, twelve CAM variants of TG37A were evaluated for yield under rainfed condition keeping TG37A as control. The pod yield of variants ranged from 2590 kg/ha to 4110 kg/ha against 3177 kg/ha for TG 37A. Yield of DGRMB5, DGRMB19, DGRMB24 and DGRMB32 were significantly higher than TG37A (Table 7).

E. Evaluation of the role of endophytes (J22 and SEN29) in alleviating the moisture-deficit stress in groundnut through OFT (farmers field at Anantapur and Kalyandurga through KVK at Reddypalli and Kalyandurg)

Table 6. Evaluation of CAM transited variants of TG37A for yield (summer 2018)

Treatment	Pod yield (kg/ha)			Haulm yield (kg/ha)			% pod yield reduction	% reduction in biomass
	2 irrigations	10 irrigations	Mean	2 irrigations	10 irrigations	Mean		
DGRMB13	1899	2960	2379	3420	4583	4002	35.84	29.5
DGRMB17	2003	3000	2451	3553	4950	4252	33.23	30.1
DGRMB19	1967	3150	2508	3607	4853	4230	37.56	30.4
DGRMB29	1725	3063	2344	3673	4830	4252	43.69	31.7
DGRMB3	1805	3050	2478	3790	4763	4277	40.82	28.4
DGRMB31	1859	3012	2436	3467	4827	4147	38.28	32.1
DGRMB5	1922	2828	2325	3783	4647	4215	32.04	23.7
TG37A	1323	2578	2101	2967	4877	3922	48.68	42.5
Total	1725	2955	2378	3533	4791	4162		
LSD (0.05)								
Treatment	118			150				
Irrigation Level	104			64				
TXL	294			182				



Evaluation of CAM transited variants of TG37A; left: with 2 irrigations; right: with 10 irrigations

During kharif 2018 a total of 18 OFTs on role of endophytes in alleviation of drought stress in groundnut were conducted with the help of KVKs located at Kalyandurga and Reddypalli in Andhra Pradesh. *Bacillus firmus* J22 was used as seed treatment. At Kalyandurga, 12 OFTs were

conducted strictly under rainfed condition with 50% deficient rain of about 240 mm during the crop season. There was enhancement in pod and haulm yield of groundnut by 24.3% (435 kg/ha in endophytes treatment against 350 kg/ha in farmers practice). Haulm

yield was enhanced by 31% in treated one. In Anantapur taluka, two OFTs were conducted under rainfed condition (about 50% deficient rain) and there was improvement in yield by 38.4% (494 kg/ha in OFT against 357 kg/ha in control). However, one supplementen

Table 7. Yield evaluation of C3-CAM variants of TG37A strictly under rainfed conditions during kharif 2018

Treatments	PY (kg/ha)	HY (kg/ha)	SP (%)	HKM (g)
TG37A	3177	3520	70.47	48.23
DGRMB1	2833	3433	72.00	50.77
DGRMB3	2813	3760	71.67	47.57
DGRMB5	3920	4710	72.17	50.33
DGRMB13	2933	3790	73.17	46.67
DGRMB17	2830	3523	73.67	49.90
DGRMB19	4110	4920	73.67	53.70
DGRMB20	2860	3517	72.17	48.03
DGRMB24	4040	5210	70.83	50.37
DGRMB29	2590	3843	71.83	49.17
DGRMB31	2930	3830	73.33	47.00
DGRMB32	4000	4727	72.67	50.10
DGRMB41	2893	3883	73.17	49.83
CD (0.05)	212	314	2.22	2.02

tary irrigation was provided, yield improvement was 40% with the treatment of endophyte. Further addition of one more irrigation could not improve the yield further indicating that endophytes can have pronounced impact during drought stress.

F. Evaluation of endophytes for enhancing growth and yield of groundnut (5 endophytes; rainfed, field by plant growth promoting attributes (kharif 2018))

Five endophytes (*Bacillus firmus* J22, *Bacillus subtilis*

R51, *Pseudomonas pseudoalcaligenes* SEN29, *Acinetobacter junii* J20 and *Pseudoxanthomonas maxicana* R47) were evaluated during kharif 2018 with cultivar TG37A to assess the plant growth promoting abilities of the cultures. Seed inoculation with the endophytes, in general, resulted in increase in plant biomass production, shelling percentage and hundred kernel mass. Significant enhancement in pod yield was obtained in treatments receiving R51 (20.11%) and REN47 (27.82%) cultures (Table 8). Treatments with other endophytes resulted in yields at par with control.

Table 8. Evaluation of endophytes for plant growth promotion and yield enhancement of groundnut strictly under rainfed conditions (cultivar TG37A)

Treatments	PY (kg/ha)	HY (kg/ha)	SP (%)	HKM (g)
Control	2531	3638	69.40	47.55
<i>Acinetobacter junii</i> J20	2674	4028	71.00	48.13
<i>Bacillus firmus</i> J22	2695	4080	71.38	48.95
<i>Pseudoxanthomonas mexicana</i> REN47	3235	4385	71.25	49.28
<i>Bacillus subtilis</i> R51	3040	3948	70.75	49.05
<i>Pseudomonas pseudoalcaligenes</i> SEN29	2821	4108	71.25	47.63
CD (0.05)	388	327	1.27	1.34

05 Socio-economic Research and Extension for Groundnut in Developments



Assessment of Farm-Manage-rial Abilities and Resource Use Efficiency of Small and Marginal Groundnut Farmers of High and Low Productivity Areas: Suggesting Suitable Policy Measures to Double the Farm Income

Narayanan G and Jat RA

Study on resource use efficiency: cost and returns from groundnut cultivation of small and marginal farmers

Groundnut is usually grown as one of the primary cash crops in Karnataka. There is wider yield gap exists in groundnut. To improve the productivity better resource use is essential. This will lead to attainment of desirable behavior for higher production among small and marginal farmers for high output per unit input.

For collecting primary data, survey was undertaken among 120 farmers of *Chitradurga* district with structured interview schedule in the end

of *Kharif* 2018. Farmers were chosen by following multistage random sampling method. In this study, those farmers having up to 1.5 ha were considered as marginal farmers and 1.5 to 3.0 ha as small farmers and interviewed directly among 30 farmers each from four randomly chosen villages. Apart from frequency, percentage for assessing farm-manage-rial abilities, Frontier Production Function Model was used to analyze their economic and technical efficiency.

Of much production limiting factors, low technical literacy, inadequate infrastructure, unscientific farming of groundnut growers fails them to exploit fully the potential of technology. Hence, resource use efficiency in value terms was analysed. Farmers invest about 25% of cost in seed and post harvesting practices.

The total cost of cultivation was Rs. 23668/ha. Allocative efficiency is concerned; the allocation for seed seems to be same and constant. The change may have to be effected in seed use, fertilizers, plant protection chemicals. The BC ratio, range is very narrow i.e. 1:1.3 to 1:1.8. Majority of marginal farmers (61.0 per cent) operating with 67.50 per cent of technical efficiency. About 39 per cent farmers operating with 73.0 per cent of technical efficiency. This reveals that among small and marginal farmers, with the same investment, about 32.5 per cent yield improvement can be achieved. This speaks about the reasons for having wider yield gap exists in groundnut and need to build the capacity of small and marginal farmers on better allocative efficiency there by achieveing greater resource use efficiency

Table.1: Technical efficiency of small and marginal farmers (Frontier production function model)

TE range	Farmers (%)	Average TE	% of output lose due to inefficiency
< 70%	73.2	67.50	32.50
70-80%	26.8	73.0	27.0

Table.2. Assessing the extent of farm-managerial abilities of groundnut growers

Extent of farm-managerial abilities	Marginal Farmers (60)		Small Farmers (60)	
	No. of Farmers	Percentage	No. of Farmers	Percentage
High >77	14	23.3	12	20.0
Medium ≤ 77	46	76.6	48	80.0

Sl.No.	OFTs Pod yield (Kg/ha)	FP Pod yield (Kg /ha)	Per cent Increase	OFTs Haulm yield (Kg /ha)	FP Haulm yield(Kg /ha)	Per cent Increase
OFTs on rain fed, without irrigation KVK, Kalyandurg						
Mean	435.0	350.8	24.1	643.8	497.9	31.1
OFTs on rain fed, without irrigation KVK Reddipalli						
Mean	494.4	357.3	40.0	1106	844.5	31.1
OFTs with one irrigation at 30 DAS						
Mean	732.9	627.3	16.9	1831.0	1300.0	41.14
OFTs in KVK with Two irrigation at 55&75 DAS						

Assessing the extent of farm-managerial abilities of groundnut growers:

The study was carried out for assessing the extent of farm managerial abilities of small and marginal farmers. It was found that majority of the small (60%) and marginal farmers (76%) found to have medium farm managerial abilities. Among small farmers, only about 20% of farmers found to have high

farm managerial abilities.

A detailed examination of components of farm managerial abilities performance among small and marginal farmers was carried out. The study revealed that high farm managerial ability has been found among marginal farmers in the components of supervision in cultivation of groundnut, budgeting, co-ordinating the activities than small farmers. As far as

knowledge of scientific practices was concerned almost all farmers respondents were in medium range. Hence capacity building of farmers is necessary in this component.

Evaluation of Endophytes for alleviation of drought through OFT

During *Kharif*-2018 in total 18 OFTs were undertaken with help of KVK Kalyandurg and KVK Reddipalli. In



Kalyandurg taluka 12 OFTs were conducted under rain-fed condition. The seed treatment culture given was *B.firmus* and J22. The average pod yield recorded with OFTs was 435kg/ha in

fail even in scanty rain fall (50% less rainfall situations). Further, treatment with one supplement irrigation help crop not only with stand drought but also boost yield in comparison with check.

cultivation and average gross marginal return with improved practice was Rs. 49048 /ha and Rs.67840/ha respectively whereas, in farmers practice it was Rs. 55254/ha and Rs. 61114/ha respec-

Group name	Yield (Kg/ha)					
	Pod		% of pod yield	Haulm yield		% of Haulm yield
	IP	FP		IP	FP	
Group -1	1608	1449	11	2185	1970	11
Group -2	1411	1289	10	1892	1729	10
Group -3	1133	1021	12	1506	1366	11
Group -4	1546	1373	13	2000	1767	14
Group -5	1390	1247	11	1834	1631	12
Average	1417	1275	11	1883	1692	11

comparison with FP 350 kg/ha. The Haulm yield difference was 31 % higher in OFTs in comparison with farmers practice. In Anantpur taluka two OFTs were undertaken under rainfed condition that reported 494kg/ha and 357kg/ha among OFT & FP respectively. Other 4 OFTs with irrigation also conducted. Amongst them the pod yield was significantly higher in two OFTs with 1 supplementary irrigation (40 %) yield difference and at the same time with two irrigations the yield difference was only (4%). Hence, it may be concluded that the culture may help the crop to be drought tolerant and not makes crop

FLDs conducted through MGMG villages

Improved variety: GJG 20 Farmers Practice: GG20

The data revealed from 125 FLDs with improved practice GJG 20 recorded an average pod yield of 1417 kg/ha compared to 1275 kg/ha with farmers practice. The pod yield increased by 11.5 per cent with improved practice over farmers practice. The average haulm yield was 1883 kg/ha with improved practice compared to 1692 kg/ha with farmers practice. The haulm yield with improved practice was 11.7 per cent increased over farmers practice. The economics display in average cost of

actively. The gross return increased by 11 per cent. The average net return with improved practice Rs. 66297 / ha compared to Rs. 60250/ha with farmers practice and increased by 10.8 per cent. The Benefit Cost (B:C) ratio was 2.1 with improved practice compared to 1.9 in farmers practice.

Visit of farmers

This year (2018-19), altogether 564 visitors from various states viz. Gujarat, Maharashtra, Uttarkhand and Rajasthan visited this Directorate. It includes a total of 564 farmers from 4 different states, 33 students from four universities and 35 women farmers. These visits were sponsored by State Depart



ment of Agriculture or State Agricultural universities concerned. All visiting groups were taken to the demonstration fields, provided with Hindi, Gujarati and English literatures; shown field experiments, Technology Park, laboratories, museum, library etc. and interaction meetings with the scientists were also arranged.

Development activities for tribal and hill regions: Reaching the unreached

Groundnut is an important oilseed crop in tribal areas not only to enrich the soil but also the life of tribal farmers in terms of income and nutritional security. Tribal mostly cultivate the poor yielding groundnut varieties along with minor cereals. Among them, groundnut cultivation as sub-system in their primitive farming is a non-profitable one with their poor knowledge on improved adoption practices and less efficient resource use management behaviour. Thus, training of tribal farmers on improved technologies and supply inputs was need of the hour to establish remunerative groundnut farming system.

With this rational in mind, the ICAR-DGR through Tribal Sub Plan (TSP) had collabo-

ration with SAUs and KVKs where tribal farmers are more in number and able to cultivate groundnut if they trained. Generally the seed given to these farmers will be brought back and distributed to other beneficiaries in the next season. Thus this process will be continued till having to establish groundnut as suitable livelihood crop among tribal farmers. There by economic growth of area will be improved. At the time of implementation, the specific objectives kept were:

- I. Empowering the tribal population through advanced management practices in groundnut like., deep ploughing, seed treatment, pre-emergence weedicide application, soil test based fertilizers applications, farm mechanization, inter cropping system etc.,
- II. Improving productivity levels by supplying the high yielding multiple resistant groundnut varieties which can withstand drought and diseases at the same time yielding high while compared with old varieties.
- III. Enhancing the economic status of tribal populations by increased productivity there by leading to sustainable livelihood.
- IV. Developing community seed banks among tribal farmers.

- V. Introducing the farm mechanization technologies there by reducing the labor cost.

During 2018-19 to conduct the On-Farm Demonstration on groundnut with latest varieties and technologies about Rs.21.46 lakhs was sanctioned to BCKV agricultural university, Kalyani, West Bengal, Agricultural Research Station, Vizianagaram, and covered about 170 tribal farm families.

06 Highlights of AICRP on Groundnut: 2018-19



I. Crop Improvement

1. Maintenance, multiplication and characterization of groundnut germplasm

- 60 wild *Arachis* accessions representing six sections of the genus *Arachis*: section *Arachis* (40 accessions); *Erectoides* (12 accessions); *Caulorhizae* (2 accessions); *Rhizomatosae* (2 accessions); *Extranervosae* (2 accessions); and *Heteranthae* (2 accessions) are being maintained in the field gene bank at Vridhachalam.
- In the same centre, a field gene bank comprising four allotriploids {(*A. hypogaea* cv. VRI 4 x (*A. correntina* X *A. helodes*); *A. hypogaea* cv. VRI 2 x *A. correntina*; *A. hypogaea* cv. VRI 2 x *A. kemppfermeradoi* and *A. hypogaea* cv. VRI 2 x *A. cardenasii*}; three autotetraploids developed from two diploid species of the section *Arachis* (*A. villosa* and *A. stenosperma* and one species from the section *Erectoides* viz. *A. rigonii*); 11

amphidiploids ($2n=4x=40$) obtained through direct hybridisation between diploid wild species and tetraploid cultivated species were also being field maintained.

- From fourteen interspecific crosses effected in kharif 2017, 64 true F_1 hybrids were identified; to recover the genome of recurrent parents, 272 BC_1F_1 plants were recovered from nine interspecific cross-combinations in rabi-summer 2017-18. In kharif 2018, 18 interspecific crosses have been made introgressing the alien genes through triploid and tetraploid pathways.
- Four thousand one hundred and forty-six (4146) germplasm accessions are being maintained at 11 centres. This included 60 wild accessions; 19 interspecific derivatives; exotic collection; 2834 Spanish bunch accessions; 53 Valencia accessions; 810 Virginia Bunch accessions; 374 Virginia Runner accessi-

ons; and four other germplasm accessions.

- Few promising genotypes, soil borne (stem rot and collar rot) diseases (K1812, JL 1176, CS-319, JL-977, JL-977, HNG-10, HNG-10, ICGV-86325, CS-19, GG-16) and earliness with fresh seed dormancy (TCGS 1157, TCGS 1694, VG 13127, VG 13149, VRI 8).

2. Hybridization programme

- For developing high-yielding groundnut cultivars possessing resistance to various biotic and abiotic stresses which limit yield in season, 98 single-crosses during rabi-summer and 189 in crosses in kharif 2018 were made different AICRP-G centers
- During rabi-summer progenies of 362 crosses were advanced to their respective next filial generation from which a very large number (10646) of selections were made
- During rabi-summer, proge-



nies of 312 crosses were advanced to their respective next filial generation and in *kharif* season; progenies of 1513 crosses were advanced to their respective next filial generation from which very large number of objective specific selections was made. Of the total crosses, which were advanced to different filial generations, in *rabi*-summer, 136 crosses were in early generations (F_1 - F_3) and in *kharif* progenies of 1154 crosses were in early generations (F_1 - F_4) and the rest were in advanced generations (F_5 onwards).

3. Varietal evaluation at multi-location

- A three tier system of evaluation of groundnut entries under the nomenclature of Initial Varietal Trial, Stage I (IVT I); Initial Varietal Trial, Stage II (IVT II) and Advanced Varietal Trial (AVT) was adopted and the trials were allotted to 25 centers located in five agro-ecological zones of groundnut both in *kharif* and *rabi*-summer
- During *kharif*, 16 entries of Spanish Bunch; 10 entries of Virginia in IVT-I; 19 SB entries, 12 genotypes of Virginia and 6 large seeded genotypes in IVT-II were tested across the five zones with appropriate checks. Entries of IVT-I will be evaluated for one more year in IVT-II.
- In IVT-II, during *kharif*, the

genotype Dh 257 (Proposed by UAS, Dharwad) promoted to AVT in Zone II (Gujarat and southern Rajasthan) with a high pod (3161 kg/ha) and kernel (2304 kg/ha) yield (10% higher over the best check, GG 7) and K 1812 with high pod (3385 kg/ha) and kernel (2346 kg/ha) yield (13% higher kernel yield) over the best check, R 2001-2 was promoted to AVT in Zone V (Tamil Nadu, Andhra Pradesh, Karnataka).

- At LSVT (Large Seeded Varietal Trial) out of seven test genotypes, two genotypes viz. K 1574 (2825 kg/ha of pod and 1994 kg/ha of kernel yield) followed by ICGV 06189 (2768kg/ha of pod and 1960 kg/ha of kernel yield) respectively. Both these genotypes recorded 10% higher kernel yield over the best check BAU 13 and hence promoted to ALSVT.
- In *kharif* 2018, at AVT, the genotype Dh 256 was found superior over the best check R 2001-2 in Zone V (Tamil Nadu, Andhra Pradesh, Karnataka). Across different stages of testing from 2016 to 2018, the genotype, Dh 256 (Proposed by UAS Dharwad), recorded a high pod (3258 kg/ha) and kernel yield (2183 kg/ha) against the best zonal check variety, R 2001-2 with 2837 kg/ha of pod 1882 kg/ha of kernel yield. Over different check varieties, the increase in pod yield of Dh 256 was 61.2% over GPBD 4; 29.9%

over GJG 32; and 20.1% over R 2001-3 and 14.8% over the best check of this zone R 2001-2 respectively. Increase in kernel yield of Dh 256 over these check varieties was 59.3% over GPBD 4; 36.6% over GJG 32; 20.2% over GJG 32 and 16.0% over the best check of this zone R 2001-2 respectively. Oil content of Dh 256 is 50%. Hence proposed for identification.

4. High oleic Acid Varietal Trial (AVT-I; HOVT SB & VG)

- A special trial on High oleic Acid Varietal Trial (HOVT) was constituted in *kharif* 2018 (first year) with eight elite Spanish Bunch and six elite Virginia genotypes developed by ICAR-DGR Junagadh (6 VG entries), JAU Junagadh (5 SB entries) and UAS Raichur (3 SB entries). The check varieties used were TG 37A, GPBD 4 and GJG 32 (ICGV 03043) in Spanish Bunch trial and GG 20, KDG 128 (Phule Warna) and KDG 123 (Phule Morna) in Virginia trial. The trial was conducted at six locations, Tindivanam (Tamil Nadu), Palem (Telengana), Tirupati (Andhra Pradesh), Dharwad (Karnataka), Junagadh (Gujarat), and Durgapura (Rajasthan). The mean yield levels of the Spanish Bunch test materials including those of check varieties were 2746 kg of pod and 1806 kg per ha of kernel.



5. High oleic Acid Varietal Trial (AVT-I; HOVT SB & VG)

- A special trial on High oleic Acid Varietal Trial (HOVT) has been constituted during *kharif* 2017 with 18 genotypes. The check varieties used were TG 37A, GPBD 4 and GJG 32 (ICGV 03043). There were six locations Tindivanam (Tamil Nadu), Palem (Telengana), Tirupati (Andhra Pradesh), Dharwad (Karnataka), Junagadh (Gujarat), and Durgapura (Rajasthan).
- Across different locations and over two years, the check variety ICGV 00343 recorded 52.58% oleic acid. Whereas two genotypes ICGV 15083 and ICGV 15090 78.2% oleic acid which fulfills the bench mark (78%±2) set for high Oleate lines.
- Over different check varieties, the increase in pod yield of ICGV 15083 was 57.3% over GPBD 4; and 41.4% over TG 37A, but fell short by just by 2.9% over ICGV 00343 (GJG 32). Whereas increase in kernel yield of this genotype ICGV 15083 over these check varieties was 56.4% over GPBD 4; and 36.0% over TG 37A, but was less by 3.8% over ICGV 00343 (GJG 32) respectively. The genotype ICGV 15083 matured in 112d with 67% of shelling; 43 g as Hundred Seed Mass, which was comparatively higher over all the check varieties

and with high oil, content (53%) which is 1-2% higher over all the checks. Protein content of this genotype was 27% and comparable with that of other check varieties.

- Over different check varieties, the increase in pod yield of the other entry ICGV 15090 was 52.7% over GPBD 4; and 37.3% over TG 37A, but fell short by 5.7% over ICGV 00343 (GJG 32) respectively. Whereas increase in kernel yield of this genotype over these check varieties was 54.0% over GPBD 4; and 33.9% over TG 37A, but was less by 5.3% over ICGV 00343 (GJG 32) respectively. The genotype ICGV 15090 matured in 113d with 67% of shelling; 41 g as Hundred Seed Mass, which was comparatively higher over all the check varieties and with a high oil content (53%) over all the checks. Protein content of this genotype was 26% and comparable with that of other check varieties. Hence these two high Oleate lines are proposed for identification.
- In *rabi*-summer 2017-18, one genotype, J 95 (with 4558 kg/ha of pod and 3367 kg/ha kernel yields in Zone I (Punjab and UP)); two genotypes, Dh 257 (with 3854 and 2788 kg/ha of pod and kernel yield) and K 1812 (with 3854 and 2788 kg/ha of pod and kernel yield) in zone IIIa (Maharashtra, Karna

taka); and J 94 (with 3293 kg/ha of pod and 2283 kg/ha kernel yield in Zone IIIb (Tamil Nadu, Telengana, Andhra Pradesh) and KGL 1322 (with 3047 kg/ha of pod and 2182 kg/ha of kernel yield) for Zone IIIb and Zone IV (Odisha, West Bengal, Manipur) were promoted to AVT based on their superiority over the best check of their respective zone and are currently in verge of their evaluation.

6. Breeder Seed Production

- During *kharif* 2018, DAC indents to the tune of 10458.91q of breeder seeds were received for 48 groundnut varieties. Based on the availability of nucleus / breeder seed stage I, a production target of 10167.23q was assigned for 46 groundnut varieties to 21 centres. During *kharif* 2018, a total quantity of 2940.55q breeder seed could be produced. To mitigate the short fall, a compensatory programme was undertaken during *rabi*-summer 2018-19 and the anticipated production is about 6382.50q. Thus, the total expected production of groundnut breeder seeds during 2018-19 would be 9323.05q.

II. Crop Production

Kharif 2018

1. Effect of paclobutrazol on growth and productivity on rain fed groundnut



The experiment was conducted at Bhubaneswar and Shirgaon during kharif, 2018. At Bhubaneswar single spraying at 30DAE of Paclobutrazol @100ppm gave significantly higher dry pod yield. While at Shirgaon double spray of paclobutrazol @ 100 ppm at 30 and 50 DAE gave significantly higher pod yields (2619 kg/ha)

2. Evaluation of DAPG-producing fluorescent pseudomonads for enhancing nutrient use efficiency, bio-control of soil-borne diseases and yield of groundnut

The experiment was conducted at Raigarh during kharif, 2018. Application of DAPG 1 gave the highest dry pod yield but was found to be non-significant.

3. Studies on tank mix application of post-emergence herbicides for efficient weed control in groundnut

The experiment was conducted at Mohanpur during kharif, 2018. Significantly highest pod yield was found with weed free check followed by farmers practice (Hand weeding at 15 and 30 DAS), which was at par with the application of pendimethalin as pre-emergence along with tank mix of imazethapyr and quizalofop ethyl either 50: 50 or 60:40. Weed control efficiency was found maximum with tank

mix application of Imazethapyr (60%) + Quizalofop ethyl (40%)

4. Identification of rainfed groundnut+millet intercropping system for red soils of Karnataka

The trial was conducted at Dharwad and Hiriyur during kharif, 2018. At Dharwad significantly higher groundnut pod equivalent yield was obtained with groundnut + little millet (4:2) while at Hiriyur sole groundnut gave significantly higher groundnut pod equivalent yield.

5. Response of kharif groundnut to plant geometry and fertility levels

The trial was allotted at Bawal, Gwalior, Raigarh and Jodhpur during kharif, 2018. Bawal centre did not report any result. At Gwalior 75% RDF gave the significantly higher pod yield with plant population @ 3.33 lakh ha⁻¹ (30 x 10 cm) but plant population treatment did not have any significant effect on pod yield. At Raigarh 125 % RDF and Plant population @ 3.33 lakh ha⁻¹ recorded the highest pod yield but found to be non-significant. At Jodhpur significantly higher pod yield was observed with 125 % RDF while plant population @ 4 lakh ha⁻¹ gave highest pod yield without having significant effect on pod yield.

6. Alleviation of moisture deficit stress in groundnut by

application of endophytic bacteria

The experiment was conducted at Akola, Durgapura, Hiriyur, Kadiri and Tirupati during kharif, 2018. At Akola significantly higher dry pod yield was recorded with any DGREB Culture with normal inter-culturing while at Durgapura DGREB-1 with suggested inter-culture operations gave the highest dry pod yield but did not have any significant effect. At Hiriyur, DGREB-3 (i/c 15 days interval) obtained significantly higher pod yield. At Kadiri significantly higher yield was gained with DGREB-2 and at Tirupati DGR Endophytic Bacteria 1 (DGREB 1) with normal inter cultural operations provided highest pod yield without having significant effect.

7. Standardization of sowing depth of groundnut crop in light soils of hyper arid regions

The trial was conducted at Bikaner during kharif, 2018. Significantly higher pod yield was obtained with 7 cm depth of sowing.

8. Identification of remunerative groundnut-based cropping systems

The experiment was conducted at Dharwad, Jalgaon, Junagadh and Vridhachalam. At Dharwad significantly higher groundnut pod equivalent yield was obtained with



Groundnut+Cotton (4:2) cropping system. At Jalgaon significantly higher groundnut pod equivalent yield was found with Groundnut +Pigeonpea (4:2) cropping system. At Junagadh significantly higher groundnut pod equivalent yield was found in Groundnut-coriander cropping sequence. At Vridhachalam significantly higher groundnut pod equivalent yield was obtained with groundnut-groundnut cropping sequence.

9. Application of bio-formulations in kharif groundnut production

The experiment was conducted at Dharwad, Durgapura, Gwalior, Jalgaon, Junagadh, Kadiri, Jhargram, Shirgaon and Tirupati. At Dharwad, Durgapura and Jalgaon, Junagadh, Kadiri, Jhargram, Shirgaon and Tirupati significantly high dry pod weight was found with application of 100 % RDF and at Gwalior highest pod yield was found with 75% RDF but was non-significant. At Durgapura, Jalgaon, Kadiri and Tirupati significantly high dry pod weight was obtained with Bio-Grow bio-formulation. At Dharwad, Gwalior, Junagadh, Jhargram and Shirgaon significantly high dry pod weight was found with application of NPK liquid formulation+Zn solubilizing bacterial bio-formulation.

10. Integrated water management in rainfed groundnut

The experiment was conducted at Bhubaneswar, Gwalior, Jalgaon, Kadiri and Palem. At Bhubaneswar and Gwalior application of hydrogel @ 2.5 kg/ha along with mulching of agrowaste / weed biomass @ 5 t/ha recorded significantly higher pod yield. At Jalgaon, Kadiri and Palem application of hydrogel 2.5kg/ha + mulching 5 t/ha + use of endophytic bacteria recorded higher dry pod yield which was at par with application of hydrogel @ 2.5 kg/ha along with mulching of agrowaste/weed biomass @ 5 t/ha.

11. Identifying suitable crop geometries for mechanical intercropping in Spanish bunch type groundnut

The trial was conducted at Jalgaon, Junagadh and Bikaner. At Jalgaon, intercropping of groundnut + pigeon pea (3:1 row proportion) (60/30/30 cm) recorded significantly higher groundnut pod equivalent yield which was at par with intercropping of groundnut pigeon pea (2:1 row proportion) (60/30 cm). At Junagadh, groundnut-pigeonpea intercropping-2:1 (60/30 cm) recorded significantly higher groundnut pod equivalent yield. At Bikaner different crop geometries did not have any significant effect on

groundnut pod yield. Bhubaneswar and Hiriya did not report any data.

12. Developing Conservation Agriculture practices in groundnut-wheat cropping system

The trial is in progress at Bikaner, Durgapura, Jalgaon and Ludhiana

13. Improving phosphorus use efficiency in kharif groundnut with microbial cultures

The trial was conducted at Bikaner, Hiriya, Junagadh, Ludhiana, Jhargram, Puducherry, Tindivanam and Vridhachalam. At Bikaner significantly highest pod yield was recorded with application of 60 kg P₂O₅ with or without DGRC culture. At Hiriya, application of 40 kg/ha of P + DGRC culture recorded significantly higher dry pod. At Junagadh, different phosphorus doses alone and in combination with DGRC culture did not have any significant effect on pod yield. At Ludhiana, application of FYM @ 2.5 t/ha + DGRC culture recorded significantly higher pod yield. At Jhargram, Puducherry and Vridhachalam, application of 60 kg P₂O₅/ha + DGRC recorded significantly higher pod. At Tindivanam significantly higher pod yield was recorded with application of application of 60 kg/ha of P, which was at par with application of 40 kg/ha



of P + DGRC culture. Jalgaon centre did not report any data

14. Identification of most profitable groundnut based intercropping systems under rain fed situation

The experiment was conducted at Tindivanam Centre. Groundnut + cotton intercropping system reported significantly higher groundnut pod equivalent yield and BCR of 3.2.

15. Integrated weed management in *kharif* groundnut

The experiment was conducted at Dharwad, Durgapura, Gwalior, Hiriyur, Jodhpur, Puducherry, Raigarh, Tindivanam, Tirupati and Vridhachalam. At Dharwad, Hiriyur, Raigarhand Vridhachalam, significantly higher dry pod yield obtained with treatment pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + manual weeding at 25-30 DAS. At Durgapura, Jodhpur and Tirupati, two manual weedings at 25 and 40 DAS recorded significantly higher dry pod yield. At Gwalior and Puducherry application of pendimethalin 30EC + Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix) + quizafop - p-ethyl @ 50 g/ha at 15-20 DAS recorded significantly highest pod yield. At Tindivanam, significantly higher dry pod yield was recorded with application of Pendime

thalin @ 0.75 or 1.0 kg/ha PE* + Imazethapyr @ 75 or 100* g/ha at 15-20 DAS.

16. Optimization of seed rate for groundnut cultivars having differential seed sizes

The experiment was conducted at Bikaner, Bhubaneswar, Jalgaon and Junagadh. At Bikaner significantly higher pod yield was obtained with HNG-10 @ 210 kg ha⁻¹ and Mallika @ 240 kg ha⁻¹. At Bhubaneswar, significantly higher pod yield was obtained with Dharani (seed rate as calculated by considering HKW and recommended plant population) followed by ICGV 00351. At Jalgaon, significantly higher pod yield was recorded by Phule Morna (2538kg/ha) which was remain at par with Phule Warna and JL-776 (seed rate as calculated by considering HKW and recommended plant population). At Junagadh significantly higher pod yield was recorded by GJG 32 (Bunch type, 45cm x 10cm) (seed rate as calculated by considering HKW and recommended plant population).

17. Agronomic management of AVT

The experiment was conducted at Bhubaneswar and Tirupati. At Bhubaneswar Variety GNH 804 recorded significantly higher pod yield with RDF (25-50-50) N, P₂O₅, K₂O/ha (N in 2 splits, 80%

basal, 20% TD) at 25DAS.

At Tirupati, among the entries, Dh-256 has recorded significantly higher per hectare pod (2872 kg), kernel (1703 kg), haulm (5087 kg) over local check Dharani which recorded 1493 kg, 1035 kg and 4968 kg pod, kernel and haulm yield per hectare respectively.

Rabi-Summer 2017-18

1. Evaluation of DAPG-producing fluorescent pseudomonads for enhancing nutrient use efficiency, bio-control of soil-borne diseases and yield of groundnut.

The experiment was conducted at Puducherry, Rahuri, Tindivanam, and Tirupati during *rabi*-summer, 2017-18. At Puducherry and Rahuri DAPG-producing fluorescent pseudomonads FP 86 and at Tindivanam and Tirupati DAPG 4 was found to give significantly higher pod yield.

2. Standardization of potash levels and apportioning time in summer groundnut under drip irrigation.

The experiment was conducted at Rahuri and Junagadh during *rabi*-summer, 2017-18. At Rahuri application of 30 kg/ha K₂O in 10 equal splits while at Junagadh application of 50 kg/ha K₂O in 8 equal splits produced significantly highest pod yield.



3. Economizing phosphorus use in groundnut production by exploiting phosphorus build up in soil.

The experiment was conducted at Bhubaneswar, Dharwad, Jagtial, Jalgaon, Junagadh, Kadiri, Mohanpur, Puducherry, Rahuri, Raigarh, Shirgaon, Tindivanam, Tirupati, Vridhachalam during *rabi*-summer, 2017-18. Application of FYM @ 5t/ha +100 % RDP+DGRC 2 was found to give significantly higher pod yield at Jalgaon, Kadiri, Mohanpur, Puducherry, Shirgaon, Tindivanam, Tirupati, and Vridhachalam while application of FYM @ 5t/ha +100 % RDP+DGRC 2 gave significantly higher pod yield at Dharwad. At Bhubaneswar application of FYM @ 5t/ha +50 or 100 % RDP + DGRC 2; at Junagadh FYM @ 5t/ha +50 % RDP+DGRC 2; and at Rahuri FYM @ 5t/ha +100 % was found at par with FYM @ 5t/ha +50 % RDP+DGRC 2.

4. Fertilizer recommendation based on targeted yield concept for groundnut under alluvial zone of West Bengal

The trial was allotted at Mohanpur center for *rabi*/summer 2017-18 but the centre has not reported results.

5. Studies on tank mix application of early post emergence herbicide for efficient weed control in groundnut

At Pudducherry the highest pod yield (4735 Kg/ha) was observed with application of Pendimethalin @ 1.5 kg ai/ha (PE) + tank mix of Imazethpyr (50%) + Quizalofop ethyl (50%) at 20-30 DAS which was followed by Pendimethalin @ 1.5 kg ai/ha (PE) + tank mix of Imazethpyr (60%) + Quizalofop ethyl (40%) at 20-30 DAS (4496 Kg/ha). While Tindivanam, pre-emergence application of Pendimethalin @ 1.5 kg a.i./ha (PE) followed by 50 % tank mix application of each of Imazethpyr @ 37.5 g a.i./ha + Quizalofop ethyl @ 25 g a.i./ha at 20-30 DAS as early post-emergence was found effective for weed management and higher yield (2244 kg/ha) of groundnut.

6. Evaluation of suitable varieties with nutrient levels for potato-groundnut system.

The trial was allotted at Deesa, Mohanpur and Mainpuri centers for *rabi*/summer 2017-18 but only centre has reported the results.

7. Irrigation Management in Potato-Groundnut Systems in light soils.

The trial was allotted at Deesa, Mohanpur and Mainpuri centers for *rabi*/summer 2017-18 but none of the centres have reported results.

8. Efficacy of herbicide application on groundnut under rice-fallow.

The trial was allotted at Akola, Bhubaneswar, Dharwad (Kumta), Kadiri (Vijayanagaram), Mohanpur, Raigarh, Tindivanam, Vridhachalam for *rabi*-summer 2017-18 and all the centres except Kadiri (Vijayanagaram) and Raigarh have reported the results. At Akola significantly highest dry pod yield (2084 kg ha⁻¹) was gained from weed free check and followed by two hand weeding treatment. Whereas among the herbicidal treatments application of Pendimethalin 30 % E.C @ 1.5 kg a.i. ha⁻¹ (Pre E) + Imazethpyr 10 % S.L @ 75 g a.i. ha⁻¹ (Post E) at 20-30 DAS recorded superior dry pod yield (1724 kg ha⁻¹) than the application of Pendimethalin 30 % E.C @ 1.5 kg a.i. ha⁻¹ + Quizalofop-ethyl 5 % E.C @ 50 g a.i. ha⁻¹ at 20-30 DAS. At Bhubaneswar best herbicidal response to weed density and weed dry matter was observed from application of Pendimethalin 30% EC@1.5 kg/ha+ 1 HW(25 DAS) as well as with 2 HW(20 and 40 DAS). At Dharwad Significantly higher dry pod yield obtained with weed free treatment (2603 kg ha⁻¹) which was at par with pendimethalin 30% E.C. @ 1.5 kg a.i./ha + One hand weeding at 25 DAS (2457 kg ha⁻¹). Further, pendimethalin 30% E.C. @ 1.5 kg a.i./ha + One hand weeding at 25 DAS (2457 kg

ha⁻¹) was at par with pendimethalin 30% E.C. @ 1.5 kg a.i./ha + quizalofop-p-ethyl 5% E.C.@ 50 g a.i./ha at 20-30 DAS(At 2-5 leaf stage weeds) (2345 kg ha⁻¹) and pendimethalin 30% E.C. @ 1.5 kg a.i./ha + imazethapyr 10% S.L. @ 75 g a.i./ha at 20-30 DAS(At 2-5 leaf stage weeds) (2334 kg ha⁻¹). At Mohanpur The highest pod yield (2963 kg ha⁻¹) was obtained with the treatment Weed free which was significantly superior to rest of the treatments. But chemical weed controls increased the pod yield a tune of average 26 % and maximum was 36 % over un-weeded control. At Tindivanam application of Pendimethalin @ 1.5 kg a.i / ha (PE) + Tank mix Imazethpyr (50%) + Quizalopfop ethyl 50 (50%) at 20-30 DAS resulted in higher groundnut pod yield. At Vriddhachalam Application of Pendimethalin 30% EC @ 1.50 kg a.i/ha + one hand weeding at 25 DAS recorded higher pod yield (2785 kg/ha) and it was statistically superior to the rest of the herbicide combination treatments.

9. Agronomic practices for Rice-fallow groundnut.

The trial was conducted at Dharwad (Kumta), Kadiri (Vizianagaram), Mohanpur, Pudukcherry, Raigarh, Shirgaon, Tindivanam, Vriddhachalam during and all the centres except Kadiri

(Vizianagram) and Raigarh have reported the results. At Dharwad groundnut variety Dh-101 recorded higher dry pod yield(2592 kg ha⁻¹) and haulm(2638 kg ha⁻¹) yield than Dh-86(2412 kg ha⁻¹ and 2563 kg ha⁻¹), respectively. At Mohanpur, TAG24 and TG51 remained at par with respect to pod yield. The groundnut variety TKG Bold recorded significantly higher pod, kernel and haulm yield (2599, 1897 and 2714 kg ha⁻¹, respectively) over groundnut variety Konkan Gaurav (2269, 1674 and 2401 kg ha⁻¹, respectively). At Tindivanam, higher growth and yield parameters were observed in TMV 13 under rice fallow groundnut system over TMV 7. At Vriddhachalam, VRI 8 produced higher pod yield over VRI 7. At Dharwad (Kumta), Mohanpur, Shirgaon, and Vriddhachalam application of 125 % RDF + Rhizobium gave significantly higher pod yield while at Tindivanam application of 100 % RDF + Rhizobium gave significantly higher pod yield.

10. Application of bio-formulations in rabi-summer groundnut production.

The trial was conducted was at Akola, Dharwad, Jalgaon, Junagadh, Kadiri, Mohanpur, Rahuri, Tirupati for rabi-summer 2017-18 and all the

centres except Akola have reported the results. Application of 100 percent RDF was found to produce significantly higher yield over rest of the treatments at all the centres. At Tirupati, yield levels were comparable with the application of 100 percent and 75 percent RDF. At Dharwad and Mohanpur, application of NPK liquid formulation + Zn solubilizing bacteria produced significantly higher pod yield over biogrow and control. At Jalgaon and Rahuri, significantly higher pod yield was obtained with the application of biogrow. While at Junagadh, the yield levels were at par with the application of NPK liquid formulation + Zn solubilizing bacteria and biogrow. However, at Tirupati no significant effect of application of bioformulations was observed on pod yield of groundnut.

11. Effect of foliar application of water soluble fertilizer on growth, yield and nutrient uptake of summer groundnut.

The trial was conducted at Jalgaon, Junagadh, Pudukcherry and Rahuri centres during rabi/summer 2017-18. At Jalgaon and Rahuri, application of 75% RDF+2% WSF at 45,60,75 DAS while at Junagadh and Pudukcherry application of 75% RDF+



1.5% WSF at 45,60,75 DAS produced significantly higher pod yield over control.

12. Agronomic management of AVT

No AVTs were conducted by any center during *rabi*/summer 2017-18.

III. CROP PROTECTION

Altogether 21 trials, 9 during *rabi*-summer 2017-18, 12 during *kharif* 2018 from entomology and pathology were conducted. The highlights with five recommendations from the research of selected centres are presented:

ENTOMOLOGY (*Kharif*)

❖ Insect-pests' situation:

Incidence of sucking pest and defoliators was recorded throughout the centres. *Spilarctia ablique* was observed during the entire cropping season with defoliation per cent of 2.5 to 5.5. at Dharwad. The maximum damage by *Spodoptera litura* Fab. and leaf miner was noticed during 45-75 days of crop growth wherein, *Spodoptera* damage ranged from 15-35 percent at Raichur. Latur recorded highest population of leaf hopper ranging from 5 to 25 leaf hoppers/3 leaves with damage of 25 per cent. Whereas, the population of thrips ranged from 5 to 22 leaf hoppers/3 leaves damage 16.8 thrips/3 leaves. *Helicoverpa* and leaf

miner ranged between 20 and 15 per cent in farmers field respectively.

• Occurrence of natural enemies:

Natural enemies observed during *kharif* season were predatory Coccinellids, spiders and green lace wings from Latur, Pavagada, Raichur, Vridhachalam and being maximum at Dharwad. *Nomuraea rileyi* was recorded at Dharwad causing mortality of *Spodoptera* larvae being peak during September (6.5-17%). The birds observed were mina, black dungro and cattle egret, and the major parasitoids recorded were *Apanteles sp.* and *Campoletis chloridaeae*.

• Monitoring of *Spodoptera*, *Helicoverpa*, leaf miner and sucking pest of groundnut:

Peak *Spodoptera* moths of 182 during 32nd standard week at Dharwad while in Latur it was 38th standard week, in Raichur 45th standard week (84.2 moths/trap), and Vridhachalam observed three peak catches on 27 SMW, 28 SMW and 32 SMW. The highest (26 adults) numbers of *Helicoverpa* were caught during 39th SMW at Latur and Raichur. However, leaf miners noticed were more (4.8/trap) during 38th standard week at Raichur. Leafhoppers, in yellow sticky trap were maximum on 33

and 34 SMW (16.4 and 15.4 hoppers/trap/day/acre) and there after declined to 8.6 hoppers/trap/day/acre on 39 SMW at Vridhachalam.

• Screening for resistance to insect pests:

ISK-I-2018-18 and ISK-I-2018-29 was found promising against defoliators and sucking pests at Dharwad; leaf hopper, *Spodoptera* and leaf miner in Latur, and for leaf miner at Vridhachalam. ISK-I-2017-09 was effective against thrips at Dharwad, leaf hopper, *Spodoptera* at Latur. ISK-I-2017-20 had recorded lower damage score against Thrips at Dharwad, leaf hopper and *Spodoptera* at Latur.

• Management of root-feeders in groundnut:

➤ Seed treatment with Chlorpyrifos @12ml/kg or Imidacloprid 600FS @2ml/kg were found effective in managing white grub species from 63-72% at Junagadh (Gujarat) with ICBR of 1:48 and 83-92% at Dharwad (Karnataka) with ICBR of 1:34.9

PATHOLOGY (*Kharif*)

• Diseases situation:

Monitoring of major diseases at farmers' field and research stations was reported. Maximum Late leaf spot (LLS) was reported from Aliyarnagar (7 scale) followed by Dharwad (7-9 scale), Junagadh (4-6) Ludhiana and Vridhachalam



(5-7). Early leaf spot (ELS) was moderate at Dharwad (2-5 scale) and low in other research stations. Rust was maximum at Aliyarnagar (7 scale) followed by Dharwad and Vridhachalam (5-7). Maximum Alternaria leaf blight (ALB) was reported from Vridhachalam (5 scale), Junagadh and Pavagada (3-4 scale). Collar rot from Vridhachalam (15-20%), Bikaner and Junagadh (10-14%). Dharwad and Vridhachalam reported stem rot incidence of 30%. PBNB was reported from Raichur (32-82%) and Pavagada (13%). Dry root rot was recorded high at Raichur (12-29%) and Kadiri (24-36%). PSND was reported from Kadiri (16-36%). Collar rot was maximum at Vridhachalam (21%).

- **Screening of IVT-I & AVT and other coordinated trial material for resistance / tolerance to major diseases:**

Among genotypes screened, ISK-I-2018-18 was promising to rust and LLS at Aliyarnagar, Jalgaon and LLS at Junagadh and Vridhachalam. ISK-I-2018-29 showed resistance to rust and LLS at Aliyarnagar; LLS, stem rot and dry rot in Junagadh. IVK-I-2018-9 showed resistance to rust and LLS at Aliyarnagar and collar rot incidence in Bikaner. ISK-I-2018-10 (rust and LLS) Aliyarnagar and LLS at Vridhachalam. ASK-2018-7 showed resistance to rust

and LLS at Aliyarnagar and stem rot (Junagadh) and collar rot (Kadiri). LSVT-II-2017-9 showed resistance to rust and LLS at Aliyarnagar and to collar rot and stem rot at Jalgaon. IVK-I-2018-6 was resistant against LLS at Dharwad; collar rot, stem rot, LLS and rust at Junagadh and LLS at Kadiri, and ELS, LLS, soil borne and PBNB at Raichur. ISK-I-2017-30 was resistant to LLS at Dharwad; dry root rot (DRR) at Kadiri. IVK-I-2017-3 had resistance to LLS at Dharwad and DRR at Kadiri. IVK-I-2017-27 showed resistance to LLS at Dharwad and was free from collar rot at Junagadh and Kadiri. ISK-I-2018-3 was found to be resistant against collar rot, stem rot, leaf spots and rust at Jalgaon, and collar rot at Kadiri. ISK-I-2018-4 was found resistant to collar and stem rot at Jalgaon and ELS, LLS and PBNB at Raichur. ISK-I-2018-18 was resistant to LLS and rust at Jalgaon and stem rot at Vridhachalam. IVK-I-2018-13 exhibited resistance to collar rot, stem rot, LLS and rust at Jalgaon, collar rot and stem rot at Junagadh and ELS, LLS, soil borne diseases and PBNB in Raichur. ISK-2018-1 was resistant to collar rot and LLS at Junagadh. ASK-2018-9 was free from stem rot in Vridhachalam and ELS, ALB and soil borne diseases in Raichur.

- **Validation of Management Modules for soil borne diseases:**

The module T₄ was used as check and next best performing module was T₆ at Kadiri, Dharwad, Raichur, and Vridhachalam. {T₆: Deep summer ploughing with mould board plough + Soil application of *Trichoderma* @ 4 kg/ ha enriched in 250 kg FYM/ha + Seed treatment with Tebuconazole 2DS @ 1.5 g/ kg of seeds + Soil application of *Trichoderma* @ 4 kg/ ha enriched in 250 kg FYM/ha at 35 and 70 DAS}. At Aliyarnagar, T₂ {Deep summer ploughing with mold board plough+ Soil application of *Trichoderma* @ 4 kg/ ha enriched in FYM+ Seed treatment with *Trichoderma* @ 10g/ kg of seed+ Soil application of *Trichoderma* @ 4 kg/ ha enriched in FYM at 35 days after sowing (DAS)}.

- **Management of major foliar diseases:**

- (T₄) Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seeds followed by Tebuconazole 50% + Trifloxystobin 25% WG @ 1.32 g/L (0.035%) at 40 and 65 DAS in managing LLS (75%), Rust (65%) at Dharwad (Karnataka) with ICBR of 1:10; ELS (68%), LLS (70%), Rust (67%) at Pavagada (Karnataka) with ICBR of 1:8; and ELS (68%), LLS (60%) at Raichur (Karnataka) with ICBR of



1:1.9. LLS (61%), Rust (52%), ALB (46%) at Vridhachalam (Tamilnadu) with ICBR of 1:3.97

- **Management of different insect pests and diseases through integration of different IPM modules:**

- Module 1: Seed treatment with Tebuconazole 2 DS @ 1.5 g/kg seed + Border crop with bajra (3 or 4 rows) + Need based spray of Thiodicarb 75 WP @ 1 g/L for defoliator 50-70 DAS + Need based spray of Hexaconazole 5 EC @ 1 mL/L 50-70 DAS was effective at Dharwad (Karnataka) in managing diseases like Stem rot (60%), LLS (63%), Rust (64%) with ICBR of 1:8.3. At Raichur (Karnataka) it was effective in managing diseases viz. collar rot (56%), Stem rot (35%), Dry root rot (46%), ELS (9%), LLS (28%) with ICBR of 1:9.2

ENTOMOLOGY (Rabi-Summer)

- **Insect-pests' situation:**

Sucking pests were observed in all the centres while leaf miner, *Spodoptera* were observed at Kadiri. Moderate to high incidence of thrips was recorded at Dharwad, Junagadh, Kadiri (1-7 scale), Raichur (4.6/terminal bud) and Vridhachalam (6/leaflet). *Spodoptera litura* damage was severe (6-8) in farmers' field of Vridhachalam Leafhopper and leaf miner infestation was recorded at

Kadiri (1-8). *Helicoverpa armigera* incidence was high at Vridhachalam and moderate at Dharwad and Kadiri.

- **Occurrence of natural enemies:**

The predatory insects such as Coccinellids and spiders were observed at Dharwad, Vridhachalam (1/plant) and Kadiri @ 1-4/4 sqm area. *Apanteles* and *Compoletis chlorideae* (2-10%) was observed at Kadiri parasitizing on Spodoptera, *Helicoverpa* and leafminer. In Raichur *Chelonus* sp. was noticed in the 9th standard week parasitizing leafminer.

- **Monitoring of *Spodoptera*, *Helicoverpa*, Leaf miner and sucking pests of groundnut using traps (pheromone or sticky traps):**

The highest *Spodoptera* was recorded (103/ trap) at 51st standard week in Raichur, and (6.6/day) trap at 3rd standard week in Junagadh. The peak incidence of leaf hopper was recorded (80.2/trap/week) at 52th week at Kadiri, which also recorded Leaf miner (15.6/trap) at 12th standard week.

- **Screening for resistance to insect pests:**

INS-I-2016-07 and INS-I-2016-08 recorded lower damage of thrips and leaf hopper at Dharwad, Leafhopper and *Spodoptera*

at Kadiri. INS-I-2016-01 was found effective for *Spodoptera* at Dharwad, for thrips at Junagadh and for Leafhopper at Kadiri. RSWUE- 2016-2 was efficient against leaf hopper (Dharwad) and Leafhopper & *Spodoptera* (Kadiri). INS-I-2016-6 and INS -I-2016-26 had lowest thrips damage at Junagadh and Leafhopper and *Spodoptera* damage at Kadiri. INS-I-2016-5 was resistant to thrips in Junagadh, Leafhopper and leaf miner at Kadiri. INS-I-2016-11 was resistant to thrips in Junagadh and leaf miner at Kadiri. INS-I-15 and INS-I-2016-23 was resistant to thrips ad Leafhopper at Junagadh and Kadiri. INS-I-2016-8, 23, 27, 28, 29 were resistant to Leafhopper and *Spodoptera* at Kadiri. INS-I-2016-2, 6, 9, 10, 21, 23, 26, 27, 28, 29 were resistant to Leafhopper and leaf miner at Kadiri.

- **Management of groundnut defoliator pests using botanicals:**

- Pongamia oil @ 3 ml/l or Azadirachtin 3% @ 3 ml/lit or Neem oil @ 3.0 ml/lit or Pongamia oil 50% plus Neem oil 50% @ 3 ml/l were found effective in managing defoliators viz. 31-41% (*Spodoptera*), 38-44% (Leaf Miner), 30-33% (*Helicoverpa armigera*) at Kadiri (Andhra Pradesh) with ICBR of 1:2.37. At Vridhachalam (Tamilnadu) it reduced 68-79%



Spodoptera with ICBR of 1:3.60, and 50-60% of Leaf Miner at Raichur (Karnataka) with ICBR of 1:6.73.

PATHOLOGY (*Rabi-Summer*)

- **Monitoring of major diseases of groundnut:**

The experiment was conducted at Aliyarnagar, Dharwad, Jalgaon, Junagadh, Kadiri, Raichur, Pavagada and Vridhachalam. ELS, LLS and ALB had moderate infection and ranged between 2 -7 across all the centres. Stem rot and root rot ranged between 10-22% at Aliyarnagar (22%). PBNB was highest at Raichur (16-32%).

- **Screening of IVT-I & II, AVT and other coordinated trial material for resistance/tolerance to major diseases:**

INS-I-2017-11 showed resistance to both rust and LLS at Aliyarnagar, stem rot at Dharwad, DRR at Kadiri. INS-I-2017-27 showed resistance to rust and LLS at Aliyarnagar, collar rot at Jalgaon. INS-I-2016-12 showed resistance to rust and LLS at Aliyarnagar, stem rot at Dharwad and Kadiri. INS-I-2016-13 showed resistant to rust and LLS at Aliyarnagar, collar rot at Junagadh. INS-I-2016-18 was resistant to rust and LLS at Aliyarnagar, stem rot at Dharwad. INS-I-2016-20 was resistant to rust and LLS at Aliyarnagar and stem rot at Junagadh. INS-I-2016-23 was

resistant to rust and LLS at Aliyarnagar, stem rot at Junagadh. AVT-II-2016-6 was resistant to rust and LLS at Aliyarnagar and collar rot at Jalgaon. INS-I-2017-3 recorded less incidence of stem rot in Dharwad and ALB at Kadiri. INS-I-2017-7 showed resistance to stem rot at Jalgaon, DRR and ALB at Kadiri. RSWUE-II-2016-6 and RSWUE-2016-7 were found promising against collar rot (Jalgaon) and stem rot (Kadiri). RSWUE-2016-8 was free from stem rot at Jalgaon and PBNB at Kadiri. INS-I-2017-10 was found free from collar rot at Jalgaon and ALB at Kadiri. INS-I-2017-21 was free from stem rot at Junagadh and ALB at Kadiri. INS-I-2017-6, 16, 21 shown resistances to ALB at Kadiri and collar rot at Raichur. INS-I-2017-26 had low incidence of ALB and DRR at Kadiri. INS-I-2017-12 was free from stem rot and PBNB at Kadiri. INS-I-2016-16 was free from stem rot and DRR at Kadiri. INS-I-2016-26 and RSWUE 2016-7 were free from DRR and PBNB at Kadiri.

- **Management of PBNB through integration of different modules:**

➤ (Module II) Border crop with bajra (4 rows) + Seed treatment with Imidacloprid 600 FS @1 mL/Kg seeds + Foliar sprays using Thiocloprid 480 SC @ 0.3 mL/L at 20-25 DAS followed by Fipronil 5SC @

1mL/L @ 40DAS and Acetamiprid 20 SP @ 0.2 g/L at 60 DAS) in managing thrips and PBNB with thrips damage of 52% and PBNB incidence of 62% at Kadiri (Andhra Pradesh) with ICBR of 1:2.7. At pavagada (Karnataka) it reduced thrips damage of 63% and PBNB incidence of 66% with ICBR of 1:8.95. At Raichur (Karnataka) it reduced thrips damage of 36% and PBNB incidence of 53% with ICBR of 1:8.65.

IV. AICRP-G FLDs:

FLD Results for *Kharif*2018

- During *Kharif*- 2018 FLDs were allotted in 8 states having 13 groundnut research FLD centers. The states in which FLDs conducted were Gujarat, Karnataka, Maharashtra, Rajasthan, Manipur and West Bengal. The FLDs were allotted on Whole Package (WP). Among the 550 FLDs allotted, results were received for 342 FLDs from 8 centers, which indicated 62 per cent of implementation.
- There were 10 new varieties' production potential and profitability were compared with 8 old ruling varieties which are cultivated with farmers' traditional cultivation practices.
- The average pod yield achieved was 2032 kg/ha under improved whole package of practices, in which mainly,



new varieties were demonstrated. The old varieties performance observed was 1667 kg/ha with farmer's traditional practices. The yield increase observed was 23.9 per cent. The minimum yield difference observed was 11.9 percent and the maximum was 37.0 percent.

- The average cost of cultivation with improved practice was Rs.58897 kg/ha in comparison with Rs.54198 kg/ha with farmer's practice. The maximum observed was 129922 kg/ha in improved practice and 104082 kg/ha with farmer's traditional practice.
- The average Gross Marginal Returns with improved practice was Rs.98036/ha and Rs.78461/ha with respect to traditional practices. Net returns observed was Rs.59985/ha and Rs.44177/ha for improved practice and farmer's practices respectively.
- The average B: C was 2.1 and 1.7 for improved practice and farmer's practices respectively.

FLD Results for *rabi*-summer 2017-18

- The *rabi*-summer 2017-18 FLDs were allotted in 9 states having 18 groundnut research FLD centers. The states in which FLDs conducted were Andhra Pradesh, Gujarat, Karnataka, Maharashtra,

Pradesh and West Bengal. The FLDs were allotted on Whole Package (WP) component. Among 300 FLDs allotted, from 13 centers results were received for 215 FLDs, which indicated 71 per cent of implementation.

- There were 11 new varieties' production potential and profitability were compared with 12 old ruling varieties which are cultivated with farmers' traditional cultivation practices.
- The average pod yield achieved was 2749kg/ha under improved whole package of practices, in which mainly, new varieties were demonstrated. The old varieties performance observed was 2219kg/ha with farmer's traditional practices. The yield increase observed was 25 per cent. The minimum yield difference observed was 12.4 percent and the maximum was 44.0 percent.
- The average cost of cultivation with improved practice was Rs.45682/ha in comparison with Rs.43197/ha with farmer's practice. The maximum observed was Rs.86581/ha in improved practice and Rs.99228/ha with farmer's traditional practice.

The average Gross Marginal Returns with improved practice was Rs.116948/ha and Rs.931138/ha with

respect to traditional practices. Net returns observed was Rs.63612/ha and Rs.45585/ha for improved practice and farmer's practices respectively. The average B: C was 2.5 and 2.1 for improved practice and farmer's practices respectively.



07 Externally funded projects

1. ICAR Seed Project on Seed Production in Agricultural Crops

Nodal Officer & PI:

Dr. Narendra Kumar

Co-PI:

Mr. Ghous Ali, Scientist, Agronomy, Arid Regional Campus (ARC)-ICAR-CSWRI, Bichhwal Industrial Area, Bikaner

Funding Agency:

ICAR-Indian Institute of Seed Science, Mau-275103, Uttar Pradesh

Duration: 2017-2020

Fund outlay: Rupees 8.40 Lakhs during 2018-2019

Summary

- Breeder seed production of Girnar-2 and Girnar-3 variety was taken in 5.0 ha and 14.5 at Bikaner and DGR, Junagadh respectively during 2018-19.
- Nucleus seed production of Girnar-2 and Girnar-3 variety was taken in 0.85 ha and

0.6ha. at Bikaner and DGR, Junagadh respectively during 2018-19.

- Produced a total 134.10q breeder seed of Girnar-2 (44.1q) and Girnar-3 (90.0q) variety during 2018-19.
- Produced a total 19.0q nucleus seed of Girnar-2 (10.5q) and Girnar-3 (8.5q) variety during 2018-19.
- Supplied a total 64.65q breeder seed of Girnar-2 (45.3q), Girnar-3 (19.35q) varieties to eight different indentors during 2018-19.
- Generated a revenue of rupees 10,11,618.00 from selling of the groundnut breeder seed and other produce.
- Groundnut fodder of 6.0 ha. area of Girnar-2 was handed over to ICAR-CSWRI-ARC, Bikaner.
- Organized one Groundnut farmers fair of 250 farmers of Junagadh district on 24th February 2019 at DGR Junagadh.

Breeder Seed Production Achievement:

Khariif2018:

The DAC indent of breeder seed of Girnar-2 and Girnar-3 varieties was 4.0q and 117.7q respectively for *khariif*-2019, accordingly which was undertaken in *khariif*-18. Against the BSP-I/DAC indent, breeder seed production of Girnar-2 variety was taken up in 5.0 ha. at DGR-RRS, Bikaner and Girnar-3 in 14.5 ha. (Seeds unit: 9.7ha. and Farm section: 4.8ha.) area at DGR, Junagadh. Besides that nucleus seed production programme of Girnar-2 was also undertaken in 0.85ha at DGR-RRS, Bikaner and Girnar-3 in 0.6ha area at DGR, Junagadh. Under this project, seed unit produced 44.1q and 90.0q (Seeds unit: 51q and Farm section: 39q) breeder seed and 10.5q and 8.5.q nucleus seed of Girnar 2 and Girnar-3 variety respectively. Now there is enough

Table-1: Variety-wise seed of different classes produced under ISP during *khariif*- 2018

Variety	Indent (q)		Plot no.	Area sown (ha.)		Total production (q)	Seed Production (q)		
	DAC	BSP-I		BS	NS		Breeder Seed (BS)	Nucleus Seed (NS)	TFL Seed
Girnar-2	4.0	4.0	RRS, BKN	5.0	0.85	54.6	44.10	10.5	--
Girnar-3	117.7	50.0	DGR, JND	14.5	0.6	98.5	90.00	8.5	--
Total	121.7	54.0		19.5	1.45	153.10	134.10	19.0	--

HRD programmes and field visits



Groundnut farmers fair organized on 24th February at ICAR-DGR, Junagadh



Seed production field at DGR, Junagadh



Seed production field at DGR-RRS, Bikaner



BSP monitoring team from IISS, Mau

Table 2: Details of seed materials supplied during 2018-19.

SN	Variety	No. of indentor	Breeder seed (q)	quality seed (q)	Resource generation (Rs)
1	Girnar-2	04	45.30	0.0	10,11,618.00
2	Girnar-3	04	19.35	0.0	
3	Girnar-3	--	43.25*	0.0	

*Disposed-off as general produce due to non lifting

Table 3: Details of HRD programme organized during 2018-19

SN	Programme name	Date	No of farmers	Place of farmers
1.	Groundnut farmers fair	24 th February 2019	250	15 village of Junagadh district

nucleus seed of Girnar-2 and Girnar-3 to meet out demand of breeder/quality seed of Girnar-2 and Girnar-3 for the *kharif*-2020, which will be produce in *kharif*-2019.

Distribution of seed/planting material

During 2018-19, seed unit has supplied a total 64.65q breeder seed of Girnar-2 (45.3q), Girnar-3 (19.35q) varieties to eight different indentors. Due to non-lifting of breeder seed of Girnar-3 variety (43.25q) was dispo-sed-off as general produce in the local market with the approval of the Director (Table-2).

Resource generation

During 2018-19, seed unit has generated revenue of Rs. 10,11,618/- through supplied of a total 107.9q breeder seed of Girnar-2 and Girnar-3 varieties to the different indentors. Annual budget of Rs. 8.40 lakhs received under this project from the ICAR-Indian Institute of Seed Science, Mau during the period under report (01.04.2018 to 31.3.2019).

Capacity building and technology dissemination

During the 2018-19, under HRD component of ICAR seed project organized a groundnut farmer fair on 24th February, 2019 at ICAR-DGR, Junagadh. About 250 farmers from 15 villages from Junagadh district participated in this mela. The aim this mela was to provide information on improved technology of groundnut cultivation.

2. Mapping of QTLs conferring resistance to peanut bud necrosis disease in groundnut

PI: Ms. Mital D. Jasani

Mentor: Bera SK

Funding Agency:

DST under WOS-A scheme

Duration:

3 years (April 2018- March 2021)

Fund outlay: Rs.21,55,200.00

Brief progress report of the project

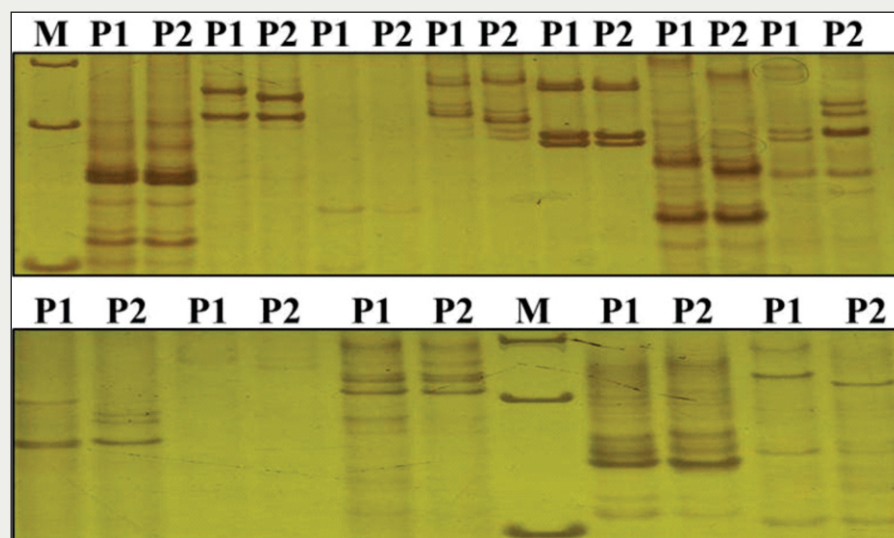


Fig. 1 Parents showing polymorphism with SSR primers, P1 & P2 indicate JL-24 & NRCGCS-86 and M indicates 100bp DNA marker



- In *kharif* 2018, 260 RILs of JL-24 and NRCGCS 86 (F6) were multiplied for further use in phenotyping and genotyping
- Phenotyping of 260 RILs along with parents has been done under UAS, Raichir, a natural hot spot for PBNB in Rabi 2019.

- A total 500 SSRs have been screened between the parents so far and 70 (14%) SSRs were found polymorphic between parents.

Study of parental polymorphism with 1500 SSRs is in progress.

3. Modelling insect pests and diseases under climate change and development of digital tools for pest management

Centre-PI (DGR, Junagadh):

Thirumalaisamy PP

Centre Co-PI (DGR, Junagadh): Harish G

Thematic Area: Pest dynamics in relation to climate change in the national innovation on climate resilient agriculture (NICRA)

Funding Agency: Ministry of Agriculture and Farmers' welfare, GoI through NICRA project

Duration: 2017-2020

Fund outlay: Rs.18 lakh for three years

Objectives

- Pest and disease dynamics, changes in crop-pest/ patho

gen relationships, changed profile of insect pests and emergence of new biotypes due to climate change, and development of forewarning system

Summary – *kharif* 2018

- About 790 mm rain-fall was received from 24th to 38th metrological week falling in the second week of June to third week of September. Rain-fed sowing was taken in the first week of July. Outbreak of *Helicoverpa* and thrips was recorded in the *kharif* groundnut. Defoliation of groundnut by *Helicoverpa* sp. was severe and less damage by Spodoptera were recorded at the crop age of 45 to 55 days as temperature 32±2°C (max.) and 25±2°C (min.) and rain-fall (about 140mm evenly distributed from 30th to 38th std. week) which favored these pest. An average of 3-5 larvae per plant was recorded in unprotected farmers' fields. Thrips damage was recorded from 32nd std. week to 42nd std. week. At the time of subside of defoliators damage, severe damage by thrips was recorded due to increased temperature from 32±2°C (max.) to 37±2°C (max.) and zero precipitation from 39th std. weeks. Besides, jassids and aphids were recorded in few fields with low infestation.

- Foliar diseases (ELS and LLS) were not developed beyond 3 and 6 grade of 1-9 scale,

respectively, during the crop period, due to increased temperature from 32±2°C (max.) to 37±2°C (max.) and zero precipitation from 39th std. week coinciding the crop age of 60 days to till harvest. Maximum disease severity of LLS was recorded at the crop age of 70-80 days, coinciding the std. week of 42-43.

- Farmers taken groundnut in pre-monsoon sowing was suffered with collar rot. The incidence of collar rot and stem rot was ranged from 0 to maximum of 4 plants out of 10 plants in few fields in the month of August (34th std. week).
- Special efforts were taken to manage the white grub damage in groundnut by ICAR-DGR. White grub damage in groundnut was well tackled by adopting prophylactic control measures (spray of insecticide on host trees and seed treatment with insecticides) by the farmers.

4. All India network project on soil biodiversity-biofertilizers

PI: Pal KK

CO-PI: Dey R

Funding agency: ICAR

Duration: 01.04.2017-31.03.2020

Fund outlay: Rs. 11.00 lakh

Objectives:

- Identification of drought- and salinity- tolerant rhizobia for enhancing BNF and yield of groundnut



Table 1. Evaluation of rhizobia under moisture-deficit stress (five alternate irrigations at 15 d interval from date of germination), cultivar TG37A (summer 2018)

Treatment	PY (kg/ha)	HY (kg/ha)	NN/p
Control	1961	4400	16.3
NC92	2009	4753	23.2
DGR-Rhi11	2099	4820	24.3
DGR-Rhi19	2126	4580	20.3
DGR-Rhi10	2036	4730	23.9
DGR-Rhi17	2520	5050	32.6
CD (0.05)	208	332	5.1

- Microbial diversity in groundnut based cropping systems
- Development of formulation of bioinoculants

Achievements:

- Four groundnut rhizobia viz. DGR-Rhi10, DGR-Rhi11, DGR-Rhi17, DGR-Rhi19 along with standard isolate NC92 were evaluated with application of irrigation at 15 days interval after emergence. These rhizobia were capable of tolerating matric potential of -2.5 MPa to -3.5 MPa. Application of DGR17 significantly enhanced the pod yield, haulm yield,

nodulation and shelling out-turn (Table 1) of groundnut (cvTG37A).

- Seventy-seven rhizobia, tolerant to moisture-deficit stress, have been isolated and identified by 16S rRNA sequencing. Majority of them belonged to *Rhizobium* sp., *Rhizobium tropici* and *Ochrobactrum* sp.

5. Exploring the diversity of extreme halophiles by functional and comparative genomics for isolating novel genes and alleles for affording salinity tolerance to crop plants

PI: Pal KK

CO-PI: Dey R

Funding agency: ICAR through AMAAS project

Duration: 01.04.2017-31.03.2020

Fund outlay: Rs. 31.64 lakh

Objectives:

- To understand the biochemical and molecular bases of osmoadaptation and osmoregulatory mechanisms of selected extreme halophilic bacilli, archaea and fungi on evolutionary perspective
- To identify candidate gene(s) having relevance to salinity tolerance for future exploitation in development of crops tolerant to salinity

Significant Achievements:

- Besides validation of expression of genes/enzymes linked to alternate carbon (survival and multiplication) in extreme haloarchaeon 3A1-DGR via the action of bicarbonate transporter (Bic), phosphoenolpyruvate orthophosphate dikinase (PPDK), phosphoenolpyruvate carboxylase (PEPC) and

Table 1. Over-expression of genes of the enzymes linked to over-expression of serine-glyoxylate cycle

Treatment	Genes/enzymes				
	Serine-hydroxymethyl transferase	Phosphoserine phosphatase	Serine glyoxylate aminotransferase	Methyl malonyl CoA mutase	Malate synthase
3A1-DGR (10% NaCl)	1.00 ^c	1.00 ^c	1.00 ^c	1.00 ^c	1.00 ^c
TG37A 3A1-DGR (20% NaCl)	4.79 ^b	9.23 ^b	12.05 ^b	10.18 ^b	11.12 ^b
3A1-DGR (30% NaCl)	16.47 ^a	13.56 ^a	18.09 ^a	21.54 ^a	17.07 ^a



malate dehydrogenase (MDH) utilizing dissolved CO₂ i.e. biocarbonate as carbon source and its subsequent modifications into malate when 3A1-DGR was grown at 30% of NaCl concentration as compared to when it was grown at 10% NaCl, the concomitant overexpression of Serine hydroxymethyl transferase, phosphoserine phosphatase, and serine-glyoxylate aminotransferase which will lead to production of glycine as osmoprotectant. Simultaneously, methylmalonyl CoA mutase, ethyl malonyl-CoA mutase, malate synthase, etc. were also validated in real time by designing appropriate primers using genome sequence data. Over-expression of the genes responsible for the production of the above enzymes ranged from 4.79 fold to 12.05 folds at 20% NaCl and that at 30% of NaCl it varied from 13.56 folds to 21.54 folds for different enzymes (Table 1).

6. Marker-assisted gene pyramiding for foliar diseases and high oleic acid content in groundnut

NPDF Fellow: Tejas Bosamia

Mentor: Chandramohan S

Funding Agency: SERB, DST

Duration: Two years (April 2017 to March 2019)

Fund outlay: Rs.20 lakh for two years

A total of four Advanced bac

crossed lines (ABLs_216, ABLs_2, ABLs_44, ABLs_36) as female and one high oleic acid content advanced backcrossed line (ABLs_5841) as male were selected based on presence of linked markers for foliar disease resistant and high oleic acid content respectively. The hybridizations between four ABLs_216, ABLs_2, ABLs_44, ABLs_36 with ABLs_5841 were generated a total of 61 individual F₁ plants. Of which 41 (~67%) were confirmed true hybrid based on CAPs marker. The true intercross F₁ were selfed to generate intercross F₂. A total of 343 F₂ plants from cross between ABLs_216, ABLs_2, ABLs_44, and ABLs_36 X ABLs_5841 were screened with CAPs marker to confirm homozygosity of both mutant alleles of FAD gene. Among 343 plants 40 were confirmed for homozygous double mutant for both alleles of FAD genes. These plants were also confirmed for the QTL regions on B03/ A03 and B10/A02 by foreground screening with LLS and rust resistance-linked markers IPAHM103, GM2079, Seq8D09, GM2009, GM2301 and DGR-329. The biochemical and phenotypic evaluation was carried out of marker confirmed F₂ introgression lines in kharif 2018. The seeds harvested from each positive plant were subjected to fatty acid

profiling by gas chromatography. A total of 11 lines out of 40 lines were found to have oleic acid ≥ 79 per cent while estimated on Gas chromatography. However, the oleic acid content of the rest of 29 lines was ranged from 68-78 per cent. All these lines were subjected to generation advancement and phenotypic evaluation for the foliar diseases resistance in kharif 2018 since these lines also contained QTLs for foliar diseases resistance. These lines showed a significant level of resistance to ELS and LLS (score range 2-3) as compared to the susceptible check (score range 7-8).



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Lectures Delivered

Mahatma MK

- Delivered a lead lecture on "Biotechnology for future agricultural productivity" in

State level convention of Agri-vision held at Navsari on 18.11.2018.

Narendra Kumar

- Delivered oral presentation on "Evaluation of advanced breeding lines for Alternaria leaf blight in groundnut" in the National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario (NCOS-2018) from April 7-9, 2018 at ICAR-DGR, Junagadh.
- Presented seed production achievements of 2017-18 in the XIIIth Annual Review Meeting of ICAR Seed Project- "Seed Production in Agricultural Crops" held on 9-11th May 2018 at PAJANC-OA&RI, Karaikal, Puducherry.
- Delivered a training lecture cum exposé visit on quality seed production to participants from KVK, Kodinar on dated 5th February 2019.
- Delivered a training lecture cum exposé visit on quality seed production to participants from KVK, Bhavnagar on dated 30.01.2019.

Thirumalaisamy PP

- Invited to deliver lecture on 'IPM in groundnut with special reference to Gujarat' at Anand Agril. University, Anand on 25.09.2018.

Participation in Conference / workshop/Seminar/Symposia/ Meeting

Radhakrishnan T

- Annual Groundnut Workshop

at PJTSAU from 18-20th April 2018

- Attended the National Seminar on Road Map of Vegetable Oil Production by 2022 held at PJTSAU, Hyderabad from 28-29 April 2018
- Visited AICRP-G centre (UAS, Dharwad) with the QRT team from 22-23 April 2018
- Attended the meeting on Quality Characteristics of Crops/Commodities and their Availability for Commercial Scale Processing and Value Addition in India held at NASC Complex, New Delhi on 15.5.18
- Attended the meeting for discussing seed production issues of soybean held at NASC, New Delhi on 1.8.2018
- Attended the meeting of 80th Central Sub Committee on Crop Standards Notification and Release of Varieties of Agricultural Crops, under the Chairmanship of DDG (CS) held at Krishi Anusandhan Bhavan, New Delhi on 10.08.2018
- Attended the launch meeting of Seed Hub project at IIOR Hyderabad on 11.06.18
- Attended the State Level Farmers' Mela organized as directed by the DG, ICAR at Gandhinagar from 7-9 Sept. 2018
- Organized and participated the final meeting of QRT of ICAR-DGR, Junagadh held at NASC Complex on 24.09.2018
- Attended the review meeting



- of Seed Hubs of pulses, oilseeds and nutri-cereals chaired by Secretary, DARE & DG, ICAR at Krishi Bhavan, New Delhi on 22.10.2018
- Visit of QRT team to AICRP-G centre at Bhubaneswar from 12-14 May 2018
- Attended cadre review meeting to be held at NBPGR, New Delhi on 14.05.2018
- Attended the meeting on National Mission on Vegetable Oils held at Krishi Bhavan, New Delhi on 13.03.2018
- Visited the farmers' field in Sitapur, UP from 23-24 June 2018
- Attended the training-cum-product launch meeting organized by Sulphur Mills Ltd., Mumbai at Hotel the Fern Residency, Rajkot on 26.06.2018
- Attended the meeting of cadre review of the scientific posts held on at NASC Complex, New Delhi on 17.07.2018
- Attended 81th meeting of the Central Sub-Committee on Crop Standards, Notification and Release of varieties for Agricultural Crops held at Krishi Bhavan, New Delhi on 24.12.2018
- Presented before the parliamentary review committee on Rajbhasha at Jamnagar on 16.01.2019
- Attended the final meeting of QRT (2012-2016) of ICAR-DGR at NASC Complex on 22.01.2019

- Attended the Directors' Conference held at NASC Complex, New Delhi from 31.1.19 to 1.2.19
- Attended the XXV meeting of ICAR Regional Committee No.VI held at AAU, Anand from 4-5 February 2019

Attended following Hindi (Raj bhasha) Meetings

- Hindi (Raj bhasha) meeting held on 3rd May 2018
- नगर राजभाषा कार्यान्वयन समिति प्रथम वार्षिक छह माहि बैठक दिनांक 18 मई 2018 को हुई
- Hindi (Raj bhasha) meeting held on 25th June 2018
- Hindi (Raj bhasha) Training for the DGR staff held on 27.6.18
- Hindi (Raj bhasha) meeting held on 14.8.28
- Hindi (Raj bhasha) meeting held on 30.8.18
- 14 से 20 September 2018 तक हिंदी चेतना सप्ताह का आयोजन डी जी आर में किया गया
- नगर राजभाषा कार्यान्वयन समिति नराकास(छह माहि बैठक वर्ष 2018 का आयोजन डी जी आर में 27.9.18 को किया गया
- Hindi (Raj bhasha) meeting held on 18.12.18
- 16.1.19 को संसदीय राजभाषा समिति के निरीक्षण में जामनगर में भाग लिया
- Hindi (Raj bhasha) meeting held on 7.3.19
- राजभाषा कार्यान्वयन समिति की बैठक दिनांक 22.3.19 को किया गया

Gangadhara K

- Attended AICRP-G Annual groundnut workshop from 18-20th April 2018 at PJTSAU, Hyderabad

Praveen Kona

- Undergone Professional Attachment Training (PAT) at ICRISAT, Patancheru from 11th December, 2017 to 10th March, 2018.
- Attended AICRP-G Annual Groundnut workshop at PJTSAU, Hyderabad from 18-20 April, 2018.
- Attended 21 days (14 Nov 2018 to 04 Dec 2018) winter school on "New vistas in seed production, processing, seed enhancement and marketing" at TNAU seed centre, Coimbatore.

Ram A Jat

- National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario organized by Indian Society for Oilseed Research and ICAR-DGR, Junagadh during 7-9 April, 2018 at ICAR-DGR, Junagadh.
- International Conference on Global Research Initiative for Sustainable Agriculture and Allied Sciences organized by Astha Foundation, Meerut, SKN Agriculture University, Jobner and others from 28-30 October, 2018 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur, Rajasthan.
- XIV Agricultural Science



Congress on Innovations for Agricultural Transformation” organized by NAAS during Feb., 20-23, 2019 at New Delhi.

Mahatma MK

- National Conference on “Enhancing Productivity of Oilseeds in Changing Climate Scenario” during 7-9 April, 2018 at ICAR-DGR, Junagadh and delivered oral presentation on “*Sclerotium rolfsii* alters expression of polyamines and ethylene biosynthesis genes in groundnut (*Arachis hypogaea* L.)”.
- International Conference on “Global Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS-2018)” during October 28-30, 2018 at RARI, Durgapura, Jaipur (Rajasthan) and oral presentation on “Identification of bioactive polyphenols in groundnut kernels using LC-MS/MS”.
- Food and Nutritional Conclave held at MPKV, Rahuri during 25-27 February 2019 and delivered oral presentation on “Transcriptomics of contrasting groundnut genotypes under varying temperature regimes”

Thirumalaisamy PP

- Participated in the Annual Workshop (AICRP-G) held at PJTSAU, Hyderabad from 18 to 20th April, 2018.

Bera SK

- First National Genetic Congress

on “Genetics for Sustainable Food Health and Nutrition Security”, at IARI, N. Delhi on December, 14-16, 2018.

- 14th Agri. Science Congress on “Innovations for Agricultural Transformation, 20-23 Feb, 2019 at NASC, New Delhi

Kiran Reddy

- National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario organized by Indian Society for Oilseed Research and ICAR-DGR, Junagadh during 7-9 April, 2018 at ICAR-DGR, Junagadh.
- Participated in the Annual Workshop (AICRP-G) held at PJTSAU, Hyderabad from 18 to 20th April, 2018.

AL Singh

- The Management Development Programme on Research Excellence in Organizations at Administrative Staff College Institute (ASCI), Hyderabad Aug 8-10, 2018
- 5th International Symposium on Zinc (Zinc crops 2018) for “Improving crop production and human health” from 5-7 Sept 2018 and the 6th Symposium on Phosphorus in Soils and Plants (from molecular scale to ecosystem) from 10-13 Sept 2018, both hosted by Katholieke Universiteit (KU), Leuven, Belgium.
- 41st All India Botanical Conference on the “ecological restoration, carbon sequestration and biotechnological

approaches for biodiversity conservation” from Oct 25-27, 2018, the Indian Botanical Society at Jiwaji Univ Gwalior

- Golden Jubilee International Conference of Nutrition Society of India from Nov 15-17, 2018 at ICMR-NIN, Hyderabad
- 4th International Plant Physiology Congress from Dec 2-5, 2018 at CSIR-National Botanical Research Institute, Lucknow. p.315

Dey R

- Attended the National Conference on 'Enhancing productivity of Oilseeds in changing climate scenario' jointly organized by the Indian Society of Oilseeds Research, Hyderabad and ICAR-DGR Junagadh from 7-9th April, 2018
- Attended workshops on 'Problems and prospects for commercialization of *Trichoderma*' on 24th May and 'Microbe based technologies for soil health and plant nutrition' on 25th May, 2018 at NASC Complex, New Delhi.
- Attended the training programme “MDP on Priority setting, Monitoring and Evaluation (PME) of Agricultural Research Projects” from 17-22 December 2018 at NAARM.
- Attended the ICAR-DGR Industries Interface meeting on 29-12-2018
- Participated in the 13th



International Conference on Development of Drylands held at CAZRI, Jodhpur from 11-14 February 2019 and made oral presentation of a research paper

- Participated in the XIV Agricultural Science Congress held at NASC Complex, N. Delhi from 20-23 February, 2019 and presented a poster.
- Attended a 1-day training programme on ISO 9001:2005 awareness course on 25-2-2019 provided by Assistant Manager URS verification pvt. Ltd.
- Attended हिन्दी राज भाषा कार्यशाला on 27-3-2019

Pal KK

- Attended the National Conference on 'Enhancing productivity of Oilseeds in changing climate scenario' jointly organized by the Indian Society of Oilseeds Research, Hyderabad and ICAR-DGR Junagadh from 7-9th April, 2018 and presented oral presentation of paper.
- Visited Hyderabad, Bengaluru, Dharwar for holding QRT meeting for AICRP-G centres along with Groundnut workshop from 18-20 April, 2018.
- Visited Bhubaneswar from 12-14 May, 2018 for holding QRT meeting of AICRP-G centre
- Visited Durgapura on 18-19 May, 2018 for holding QRT meeting of AICRP-G centres
- Attended workshops on 'Problems and prospects for commercialization of Trichoderma' on 24th May and 'Microbe based technologies for soil health and plant nutrition' on 25th May, 2018 at NASC Complex, New Delhi.
- Attended 13th IMC meeting of ICAR-NBAIM Mau and joint meeting of IMC and QRT at Mau, on 29th May, 2018.
- Attended 20th IMC of ICAR-DGR Junagadh on 9th July 2018 as member IMC.
- Attended QRT meeting of ICAR-DGR, Junagadh and AICRP-G centres of Northern zone as member secretary, QRT from 5-9 July, 2018.
- Invited to deliver an interactive talk "Mode of action of Nitrogen fixing micro-organisms" on 11-8-2018 at Dept. of Plant Pathology, College of Agriculture, JAU, Junagadh during a Model Training Course on 'Role of Biopesticides and Biofertilizers in Sustainable Agriculture' from August 8-13, 2018.
- Attended the DPC for promotion from Scientist to Scientist (senior scale) at ICAR-NBAIM Mau on 6-9-2018, as DG nominee in the discipline of Microbiology.
- Organized and participated in the final meeting of QRT on 24-9-2018 at NASC Complex, New Delhi and finalized the report.

Participated in the 13th International Conference on Development of Drylands held at CAZRI, Jodhpur from 11-14 February, 2019 and made oral presentation of a research paper.

Participated in the XIV Agricultural Science Congress held at NASC Complex, N. Delhi from 20-23 February, 2019 and presented a poster.

Attended हिन्दी राज भाषा कार्यशाला on 27-3-2019.

Narendra Kumar

- Attended National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario (NCOS-2018) from April 7-9, 2018 at ICAR-DGR, Junagadh.
- Attended XIIIth Annual Review Meeting of ICAR Seed Project-"Seed Production in Agricultural Crops" held on 9-11th May 2018 at PAJANCOA&RI, Karaikal, Puducherry.
- Attended monitoring of breeder seed production and AICRP-G trials in the zone-V (Tirupati, Kadiri and Hiriyur) from 10.09.18 to 16.09.18.
- Attended and assisted in organizing Annual Groundnut Workshop from April 18-20, 2018 at Prof Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad.
- Attended training of trainers programme under skill development training progra-

mme from December 17-19, 2018 at ATARI, Kanpur.

- Attended 13th International Conference on Development of Drylands (ICDD), Converting Dryland Areas from Grey to Green from February 11-14, 2019 at CAZRI, Jodhpur, India.

Awards/Recognition

Ram A Jat

- Received Distinguished Scientist award in the discipline of Agronomy by Society for Scientific Development in Agriculture &

Technology at GRISAAS 2018 held during 28-30 October, 2018 at RARI (SKN Agriculture University, Jobner), Jaipur.

SK Bera

- Selected as Fellow of Indian Society of Genetics and Plant breeding on 14.12.2018

Special assignments

Thirumalaisamy PP

- Member, inspection team of APEDA for shelling cum grading, value addition post-harvest peanut processing units at Rajkot.

- Monitoring of AICRP groundnut trails at Dharwad, Raichur and Palem-Hyderabad from 3.10.2018 to 7.10.2018.

- Survey and collection of rusts and leaf spots of groundnut from Tindivanam, Virudhachalam, Alangudi, Tirupati, Chittoor areas from 14. 02. 2019 to 22.02.2019



Dr. SK Bera Receiving Certificate & Memento for Fellow of Indian Society of Genetics & Plant Breeding on 14.12.2018

HRD Activities at ICAR-DGR during 2018-19



To improve skills in the advanced areas of modern science, the staff members of ICAR-DGR undergone various training programs. Fourteen scientists and four technical personnel undergone training on various aspects viz., seed production and enhancement, IPR management and Bio-safety, proteomics, phytoreme-

diation, experimental data analysis, J-gate CERA and MDP on HRD, PME and Leadership.

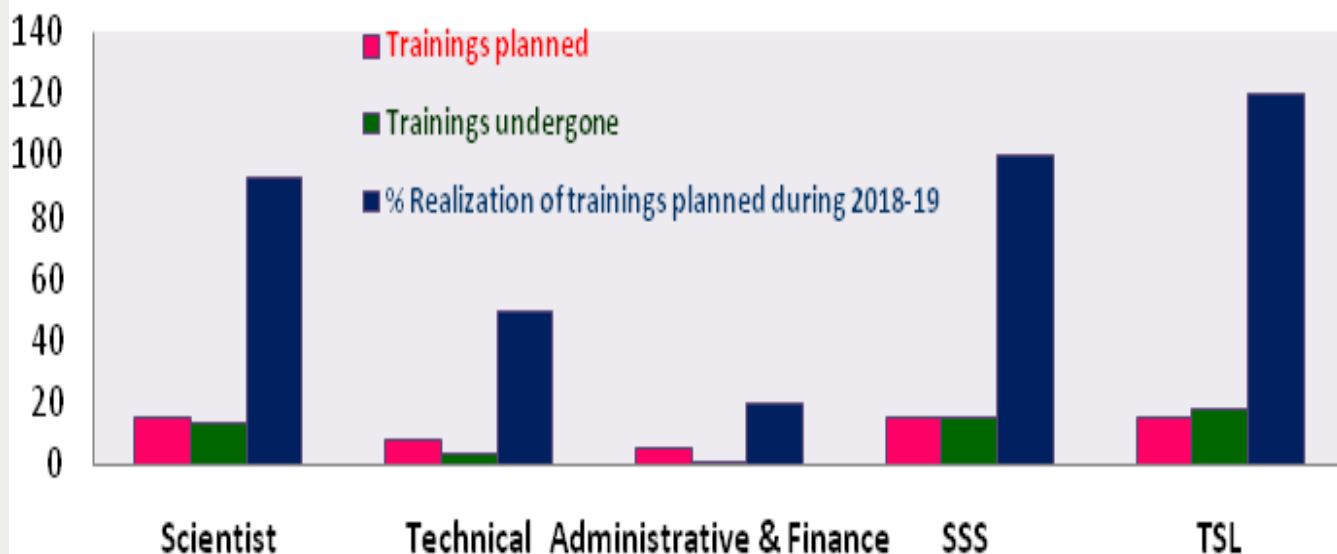
Five newly joined scientists successfully completed orientation programme at ICAR-DGR and later were sent for professional attachment training at ICRISAT, Hyderabad, ANGRAU, Tirupati, Directorate of Soybean

Research, Indore, Directorate of Rapeseed & Mustard Research, Bharatpur and Biological Survey of India, Kolkata respectively for subject matter specialization.

In house Training of SSS and TSLs of ICAR-DGR

Two training programmes were formulated and implemented for SSS and

Trainings planned and Per cent realizations of ICAR-DGR for 2018-19



TSLs of ICAR-DGR from 22-27th October 2018 with assistance of four resource persons of the institute. In order to bring awareness on general service rules among the staff, important topics

covered were Advances, CEA, Leave rules, LTC, Travelling allowance, CGHS, Conduct rules, DA and HRA, Vigilance, RTI, ERP, MACP, Pension, EPF and other benefits.

S N	Title of Training	Category of employee	Number of Participants
1	General rules, conduct rules, RTI, TA Rules, LTC and Medical Rules	SSS	15
2	General Service Rules	TSL	18



Training program for TSLs from 25-27th October 2018 at ICAR-DGR, Junagadh

Inputs: Ram Dutta and Gangadhara K

The details of the training programs implemented/attended are as under:

S N	Training Subjects/Title of the Training	Name of the employee	Category	Period	Venue
1	Programme Phyto-remediation: challenges and scope under heavy metal stress	Dr. S. Sushmita	Scientific	10-30 Jul. 2018	SDAU, Dantiwada
2	Management Development Programme on Leadership Development	Dr. A L. Singh	Scientific	8-10 th Aug. 2018	ASCII, Hyderabad
3	IPR and Technology management	Dr. S. Chandramohan	Scientific	24-29 Aug. '18	NAARM, Hyd.
4	Proteomics and its applications in Agriculture	Dr. M.K.Mahatma	Scientific	5 th -14 th Sept. 2018	PAU, Ludhiana
5	New vistas in seed production, processing, seed enhancement and marketing	Dr. K. Gangadhara Dr. Kona Praveen	Scientific	14 th Nov. to 4 th Dec. '18	TNAU, Coimbatore
6	IPR and Bio-safety of Plant Genetic Resources	Dr. K. Gangadhara	Scientific	8-17 Oct. 2018	GKVK, UAS, Bengaluru
7	Training workshop for Vigilance Officers of ICAR Institutes	Dr. A.L. Rathnakumar	Scientific	31 st Oct. to 1 st Nov. '18	ICAR-NAARM, Hyderabad
8	J-Gate @ CeRA Regional Ambassador training programme	Dr. M.V.Gedia	Technical	5 th Nov. 2018	MPAUT, Udaipur
9	Analysis of Experimental Data	Dr. D.L.Parmer Mr. Ranvir Singh	Technical	6-11 th Nov. 2018	ICAR-NAARM, Hyderabad
10	MDP on Priority Setting, Monitoring and Evaluation (PME) of Agricultural Research Projects	Dr. RinkuDey	Scientific	17-22 nd Dec. 2018	ICAR-NAARM, Hyderabad
11	Management Development Programme on Leadership Development (Pre RMP)	Dr. Ram Dutta	Scientific	18-29 th Dec. 2018	ICAR-NAARM, Hyderabad
12	A study on solvent based extraction and determination of quality parameters and other bio-molecules in Indian Mustard	Dr. AmanVerma	Scientific	26 th Nov. 2018 to 25 th Feb. 2019	DRMR, Bharatpur
13	Studies on Black gram leaf curl virus	Mr. AnanthKurella	Scientific	28 th Nov. '18 to 1 st Mar. '19	ANGRAU, Tirupati
14	Groundnut Improvement: Target traits, breeding tools and future perspectives	Mrs. Kirti Rani	Scientific	28 th Nov. '18 to 28 th Feb. '19	ICRISAT, Hyderabad,
15	Collection, preservation and identification of soil Nematodes	Mr. Rupak Jena	Scientific	4 th Dec. '18 to 23 rd Feb. '19	ZSI, Kolkata
16	Soil biological properties contributing to nutrient mobilization and assimilation in vertisols under long term rotational tillage and soybean based cropping systems	Dr. Raja Ram Chaudhary	Scientific	24 th Nov. 2018 to 23 th Feb. 2019	DSR Indore
17	Risk Assessment and Management of Non Insect Pests for sustainable Agriculture	Dr. S.D.Savalia	Technical	7-16 th Jan. 2019	NAU, Navasari
18	Goods and Services Tax	Mr. Amit Kumar	Administ-ration and Finance	28-29 th Jan. 2019	ISTM, New Delhi
19	Management Development Programme for HRD Nodal Officers of ICAR for effective implementation of Training Functions	Dr. Ram Dutta	Scientific	14-16 Mar. 2019	ICAR-NAARM, Hyderabad

Meetings



QRT Meeting of ICAR-DGR, Junagadh for the period 2012-2016

AICRP-Groundnut during the period 2012-2016 vide Council order F. No. CS. 12/

Complex, New Delhi on 3rd February, 2018 to plan the review process. The team had

The ICAR-Directorate of Groundnut Research (formerly: National Research Centre for Groundnut) was established on 1st October, 1979 at Junagadh to conduct fundamental research on all aspects of groundnut cultivation and to address issues concerning its productivity. The 7th Quinquennial Review Team (QRT) was constituted



The composition of QRT team

Name	Position
Dr. P. L. Gautam	Chairman
Dr. Masood Ali	Member
Dr. S. Acharya	Member
Dr. S. J. Kolte	Member
Dr. Arun Patel	Member
Dr. K. V. Bhat	Member
Dr. K. K. Pal	Member-Secretary

1/2007-IA.III dated 29th December, 2017.

The first interactive meeting of the team was held at NASC

an interaction with DDG (CS), Dr. A. K. Singh and ADG (O&P), Dr. P. K. Chakrabarty, who briefed about the terms



by ICAR to conduct external review of the programme and progress of ICAR-DGR and

of reference of the QRT and extent of its review. The team was also appraised about the ongoing activities and programme and achievements of ICAR-DGR, Junagadh and that of AICRP on groundnut for the period 2012-2016. The team had its second meeting at Professor Jayashankar Telangana State Agricultural University (PJ TSAU), Hyderabad during 18-21 April, 2018, which also coincided with the Annual Group Meeting of groundnut. In the meeting, the team reviewed the work of twelve of the AICRP-Groundnut centres, besides personal discussions with the scientists of AICRP-G. The QRT also attended the Annual Group Meeting of Groundnut held at PJ TSAU during 18-21 April, 2018 and reviewed the conduct and other aspects of the group meeting. Subsequently, members of QRT visited University of Agricultural Sciences, Dharwad (22-23 April, 2018); Mahatma Phule Krishi Vidyapith, Rahuri (26-27 April, 2018); Chandra Shekhar Azad University of Agriculture & Technology, Mainpuri (9-10 May, 2018); Odisha University of Agriculture & Technology, Bhubaneswar (11-13 May 2018); Sri Karan Narendra Rajasthan Agricultural University, Durgapura (18-19 May, 2018) and finally ICAR-DGR, Junagadh during 5-9

July, 2018 (review of ICAR-DGR, Junagadh and remaining centres of AICRP-Groundnut). The QRT members also visited all the laboratories of ICAR-DGR and the ongoing field experiments, other facilities and interacted with the scientists and other staff present in laboratories and field. The team also interacted with the staff in a general meeting. The team apprised the IMC, ICAR-DGR on 9th April, 2018 of the observations and general recommendations of the review. Finally, all the members of the team met at NASC Complex, New Delhi on 24 September, 2018 to discuss and finalise the recommendations and proceedings.

National conference on “Enhancing productivity of oilseeds in changing climate scenario” (NCOS) organized at ICAR-DGR, Junagadh during 7-9 April 2018

A three-day (7-9 April 2018) national conference on 'Enhancing productivity of oilseeds in changing climate scenario' was organized at DGR in association with

Indian society of oilseeds research (ISOR), Hyderabad. At inauguration, Director Dr. Radhakrishnan invited the honorable guests and participants. The Chairman of the inaugural session Dr. Trilochan Mohapatra, Secretary DARE and DG, ICAR, New Delhi appraised the participants on status of oilseeds in the country, and the significant achievements made so far for sustainable oil seed production and future prospects and challenges and Co-Chairman, Dr. A. R. Pathak, Hon'ble VC, JAU, Junagadh gave lead lecture on “Strategies for doubling of farmers' income” and Dr. A. Vishuwardhan Reddy, Director, ICAR-IIOR, Hyderabad gave opening remarks and presented an overview of conference and society. The conference covered six thematic areas during technical sessions. 1. Development of climate resilient varieties. 2. Management strategies to mitigate impact of climate change. 3. Crop protection measures to enhance productivity. 4.



Inauguration of NCOS-2018

Processing post-harvest management and value addition for harnessing the potential of secondary sources of oil. 5. Innovative approaches for rapid adoption of technologies. 6. policy frame work for oilseed sector including doubling of income. There were in toto 19 lead lectures, 74 oral presentations, 43 poster presentations and 19 special oral presentations (for students)

Groundnut Farmer Fair-cum-Exhibition

ICAR-DGR, with the financial support from NFSM, organised a Groundnut farmer fair-cum-exhibition at ICAR-DGR, Junagadh on 1st October, 2018. Junagadh Agricultural University, Department of Agriculture, Govt. of Gujarat, ATMA, Junagadh, NGOs, and dealers

of agricultural implements, inputs, irrigation systems and accessories have participated in the mela and exhibited their technologies and materials. More than 800 farmers from the different villages of Junagadh, Gir-Somnath, Amreli and Rajkot had attended the mela. Besides, 24 farmers from Odisha also participated in the mela. Dr. A. R. Pathak (Vice Chancellor, Junagadh Agricultural University), the chief guest of the function urged the groundnut farmers to adopt new improved varieties, crop production and protection practices besides intercropping/ crop rotations to make the groundnut cultivation more sustainable and profitable.

Dr. R K Mathur, Director, Indian Institute of Oil Palm, Pedavegi, the special guest of the function, highlighted the

need for enhancing the edible oil production in the country.

Dr. Manoranjan Dutta, Advisor, NFSM had explained different schemes and supports being extended by the Government to the farmers for doubling their farm income. He also insisted for higher production of groundnut to meet out ever increasing oil demand of India. Dr. Radhakrishnan, Director, ICAR-DGR has urged the farmers to adopt the improved production technologies and further mechanization to make the groundnut cultivation more remunerative. Pamphlets in local language on the integrated white grub control, management of micronutrient deficiencies, Aflatoxin management, storage pest management in groundnut and health benefits of groundnut were distributed to the farmers. Dr. V. P. Ramani, Project Incharge, AICRP on Micro Nutrient, Anand Agricultural University, Anand delivered a lecture on “Management of micronutrient deficiencies in groundnut” and had interaction with the farmers. Progressive farmers and Sarpanch from different villages adopted by the ICAR-DGR under Mera Gaon Mera Gaurav programme shared their experiences on controlling of white grub as



per technological interventions extended by the ICAR-DGR.

Industries Interface Meeting

Giving credence to the increasing importance and potentials of the Public-Private Partnerships in achieving higher groundnut productivity, efficiency, and diversification of value-added products and exports, and popularizing technologies, ICAR-Directorate of Groundnut Research has organized an Industries Interface meeting at this Directorate on 29 December, 2018. Dr. A. R. Pathak, Hon. Vice-Chancellor of Junagadh Agricultural University was the chief guest. Besides, Dr J. B. Misra, Technical Adviser, IOPEPC; Dr. P. K. Rai, Director

(Actg.), ICAR-DRMR and Director, DGR, Junagadh were the other dignitaries. The participants include the researchers, and thirty representatives from different entrepreneurs from different parts of India and representative from the Saurashtra Oil Mills Association (SOMA). The aim of this interface meeting was to address the issues concerning export, value addition, need of polarizing high oleic groundnut oil, need of application and popularization of low-cost biofertilizers for enhancing productivity of groundnut, etc. Problems faced by the groundnut confectionery industries (sound kernels, kernel shape, colour of testa, seed size, etc.), were covered

by distinguished speakers and participants.

Dr. Radhakrishnan T., Director, ICAR-DGR thanked all the delegates, which have contributed to the success of the meeting and hoped that this would surely mark a milestone in furthering the cause of all stakeholders of groundnut in increasing the productivity, popularizing the available technologies which will provide benefits to both farmers and industries through joint partnerships.





Work Plan 2018-19

Programme 1: Genetic improvement of groundnut

Breeding groundnut varieties for drought tolerance to enhance productivity in arid regions

Ajay BC, Gangadhar K, Nataraj KC, Malleswari Sadhneni

Breeding for alternaria leaf blight resistance in groundnut

Narendra Kumar, Rathnakumar AL, Praveen Kona, Dutta R and Chandramohan Sangh

Breeding for Fresh seed dormancy and reducing maturity duration in groundnut

Gangadhara, K., Rathnakumar, AL, Ajay B.C., Chandramohan, S., Sushmita S. and Praveen Kona

Genetic Enhancement and Management of Groundnut Genetic Resources

Rathnakumar AL, Gangadhara K, Bera SK, Mahatma MK and Ajay BC

Marker assisted breeding for fungal disease resistance and high oil quality in groundnut

Sangh Chandramohan, Bera SK and Narendra Kumar

Development of pre-breeding lines resistant to biotic stresses and tolerance of abiotic stress using interspecific hybridization and mutation breeding in groundnut

Bera SK, Thirumalaisamy PP, Narendra Kumar and Meena HN

Breeding for improvement of quality traits in groundnut

Praveen Kona and Mahatma MK

Programme 2: Groundnut pests and diseases-emerging problems and their management

Refinement and validation of management module for soil borne diseases of groundnut

Ram Dutta, Mahatma MK, Thirumalaisamy PP, Narendra Kumar

Biology, epidemiology and management of *Alternaria* leaf blight in groundnut

Thirumalaisamy PP and Ram Dutta

Studies on white grub and bruchid beetle and their management in groundnut

Harish G and Ram Dutta



Programme 3: Enhancing the productivity, sustainability and resilience of groundnut based production system

Development of climate resilient groundnut production systems through precision Management Practices

Ram A. Jat and Kiran K. Reddy

Management of soil and irrigation water salinity through agronomic practices in groundnut

Meena HN and Reddy KK

Efficient utilization of soil phosphorus in groundnut production system

Reddy KK, Meena HN and Jat RA

Programme 4: Biochemistry, microbiology and physiology of groundnut in relation to plant health and nutrition, photosynthetic efficiency, nutritional quality, biotic and abiotic stress tolerance

Iron and zinc bio-fortication in groundnut

Sushmita, Singh AL, Bishi SK and Gangadhara K

Physiological studies in groundnut under water-deficit and salinity stresses

Singh AL, Sushmita and Bishi SK

Impact of heat stress on groundnut metabolism and productivity

Bishi SK, Mahatma MK, Singh AL, and Sushmita

Evaluation of nutritional and bioactive compounds of groundnut

Mahatma MK, Bishi SK, Rathnakumar AL and Singh AL

Studies on microorganisms in relation to plant health and nutrition in groundnut

Dey R, Pal KK and Thirumalaisamy PP

Application of microorganisms for management of biotic and abiotic stresses in groundnut

Pal KK, Dey R, Meena HN, Mahatma MK, Harish G, Ajay BC and Reddy KK

Programme 5: Socio economic research and extension for groundnut in developments

Assessment of Farm-Managerial Abilities and Resource Use Efficiency of Small and Marginal Groundnut Farmers of High and Low Productivity Areas:

Suggesting Suitable Policy Measures to Double the Farm Income

Narayanan G and Jat RA



09 Staff List-2018-19 / General Information / Finance & Accounts

As on 01.04.2018 to 31.03.2019

S.L.	Name of employees	Designation
1	Dr. T. Radhakrishnan	Director
2	Dr. A.L. Singh	Principal Scientist, Plant Physiology
3	Dr. A.L. Rathnakumar	Principal Scientist, Plant Breeding
4	Dr. S.K. Bera	Principal Scientist, Cytogenetics
5	Dr. K.K. Pal	Principal Scientist, Microbiology
6	Dr. RinkuDey	Principal Scientist, Microbiology
7	Dr. Ram Dutta	Principal Scientist, Plant Pathology
8	Dr. R.A. Jat	Senior Scientist, Agronomy
9	Dr. M.K. Mahatma	Senior Scientist, Plant Biochemistry
10	Dr. H.N.Meena	Senior Scientist (Transferred) Agronomy
11	Dr. S.K.Bishi	Scientist (Transferred), Plant Biochemistry
12	Dr. P.P. Thirumalaisamy	Senior Scientist, Plant Pathology
13	Dr. Harish G.	Scientist (Senior Scale), Entomology
14	Dr. Narendra Kumar	Scientist (Senior Scale), Plant Breeding
15	Dr. Ajay B.C.	Scientist (Senior Scale), Plant Breeding
16	Sh. M.V. Nataraja	Scientist (Senior Scale), Entomology
17	Dr. G.Narayan	Scientist (Senior Scale), Extension Education
18	Dr. K.Gangadhara	Scientist, Plant Breeding
19	Dr. Sangh Chandramohan	Scientist, Plant Biotechnology
20	Mr. Kiran Kumar Reddy	Scientist, Soil Science
21	Dr. Sushmita	Scientist, Plant Physiology
22	Dr. Kona Praveen	Scientist, Plant Breeding
23	Sh. Ananth Kurella	Scientist, Plant Pathology
24	Sh. Rupak Jena	Scientist, Nematology
25	Dr. AmanVerma	Scientist, Plant Biochemistry
26	Dr. Raja Ram Choudhary	Scientist, Agronomy
27	Ms. Kirti Rani	Scientist, Plant Breeding
28	Dr. D.L.Parmar	Chief Technical Officer
29	Sh. N.R. Ghetia	Chief Technical Officer
30	Sh. P.K. Bhalodia	Chief Technical Officer
31	Sh. P.V. Zala	Chief Technical Officer



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32	Dr. H.K.Gor	Chief Technical Officer
33	Sh. P.R. Naik	Assistant Chief Technical Officer
34	Sh. H.M.HIngrajia	Chief Technical Officer
35	Dr. J.R. Dobaria	Chief Technical Officer
36	Dr. M.V. Gedia	Assistant Chief Technical Officer
37	Sh. Ranvir Singh	Assistant Chief Technical Officer
38	Dr. S.D. Savaliya	Assistant Chief Technical Officer
39	Mrs. V.S. Chaudhari	Assistant Chief Technical Officer
40	Sh. B.M. Chikani	Assistant Chief Technical Officer
41	Sh. D.R. Bhatt	Assistant Chief Technical Officer
42	Sh. R.D. Padvi	Technical Officer
43	Sh. H.V. Patel	Technical Officer
44	Sh. C.B. Patel	Technical Officer
45	Sh. P.B.Garchar	Technical Officer (Death on 24.07.2018)
46	Sh. N.M. Safi	Technical Officer (Driver)
47	Sh. A.D.Makwana	Technical Assistant
48	Sh. G.G.Bhalani	Senior Technical Assistant
49	Sh. B.M. Solanki	Sr. Technical Assistant (Tractor Driver)
50	Sh. Lokesh Kumar	Sr. Technical Assistant
51	Sh. Pitabas Das	Technical Assistant
52	Sh. Indraraj Meena	Administrative Officer,
53	Sh. Amit Kumar	Finance & Account Officer,
54	Sh. R.T. Thakar	Assistant Administrative Officer
55	Mrs. Rosamma Joseph	Personal Secretary
56	Sh. Y.S. Kariya	Personal Assistant
57	Sh. L.V. Tilwani	Personal Assistant
58	Mrs. Santha Venugolan	Assistant
59	Mrs. M.N. Vaghasia	Assistant
60	Sh. M.B. KherSecurity	Supervisor
61	Sh. C.G. Makawan	Assistant
62	Sh. P.N. Solanki	Upper Division Clerk
63	Sh. R.B.Chawda	Skilled Support Staff



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64	Sh. D.M. Sachaniya	Skilled Support Staff
65	Sh. M.B. Shaikh	Skilled Support Staff
66	Sh. J.G. Agrawat	Skilled Support Staff
67	Sh. K.T. Kapadia	Skilled Support Staff
68	Sh. V.N. Kodiatar	Skilled Support Staff
69	Sh. R.P. Sondarwa	Skilled Support Staff
70	Sh. V.M. Chawada	Skilled Support Staff
71	Sh. G.S. Mori	Skilled Support Staff
72	Mrs. D.S. Sarvaiya	Skilled Support Staff
73	Sh. P.M. Solanki	Skilled Support Staff
74	Sh. N.G. Vadher	Skilled Support Staff
75	Sh. B.J. Dabhi	Skilled Support Staff
76	Sh. C.G. Moradia	Skilled Support Staff
77	Sh. D.A. Makwana	Skilled Support Staff
78	Sh. Jay R. Purohit	Skilled Support Staff

1. Staff position as on 01.04.2018 to 31.03.2019

Category of	Sanctioned Strength as on 01.04.2017	Filled As on 1.4.18	Vacant As on 1.4.18	Filled As on 31.3.19	Vacant As on 31.3.19
Scientific	39+01RMP	21+01	18	26+01	13
Technical	39	25	14	19	20
Admn.	17	11	06	11	06
SSS	19	16	03	15	04
Total	114+1 RMP	73+01	41	71+01	43



General Information

2. DPC:

1.	DPC Held on 11.09.2018 for Scientific Staff, 01 employees
2.	DPC Held on 24.01.2019 for Administrative Staff, 01 employees

3. IMC

Sr.	Name	Designation	Period
1	Director ICAR-DGR, Junagadh	Chairman	Ex-officio
2	Assistant Director General (OP), ICAR, KB, New Delhi	Member	06.08.2017 to 05.08.2020
3	Dr. S.K. Yadav. Principal Scientist. Biochemistry. CRIDA. Santoshnagar. Hyderabad-500059. Andhra Pradesh.	Member	06.08.2017 to 05.08.2020
4	Dr. Geetha K.S ., Principal Scientist, DMAPR. Anand. Gujarat.	Member	06.08.2017 to 05.08.2020
5	Dr. I.P. Singh. Principal Scientist. ICAR-Central Citrus Research Institute. Post Box No. 464. Shanker Nagar P.O. Nagpur-440010	Member	06.08.2017 to 05.08.2020
6	Dr. K.K. Pal. Principal Scientist. Microbiology, ICAR-DGR Junagadh-362001	Member	06.08.2017 to 05.08.2020
7	Sh. Manendrabhai Pithiya NR, Nagdada Temple, Talala Road, At. Gundran, TA Talala, Dist Gir Somnath- 362150	Member	06.08.2017 to 05.08.2020
8	Sh. Vraj Lal (Vajubhai), Jiva bhai, Hirpara A-107, Chanakya Apartment, NR. Nehru Park, Junagadh- 362001 (Mobile No. 987914544}	Member	06.08.2017 to 05.08.2020
9	Administrative Officer, DGR, Junagadh	Member Secretary	Ex-officio

4. Retirement:-

1.	Shri R.B. Chawda, SSS, 30.04.2018
2.	Sh. Shri A.D. Makwana, TA, 30.06.2018
3.	Shri H.M. Hingrajia, CTO, 30.09.2018
4.	Dr. H.K. Gor, CTO, Voluntary Retirement on 31.10.2018.
5.	Shri G.G. Bhalani, Sr. TA. 31.12.2018
6.	Smt. Rossama Joseph, PS, 31.03.2019



5. Transfer:-

1.	Dr. H.N.Meena, Sr.Scientist, ICAR-DGR, Junagadh to ATARIV, Jodhpur (23.06.2018)
2.	Dr. S.K.Bishi, Scientist, ICAR-DGR, Junagadh to IIAB, Ranchi (23.06.2018)
3.	Shri Anil kumar Maurya, Sr.TA, ICAR-DGR, Junagadh to IISR-Lucknow (28.06.2018)

6. Institute Joint Staff Council:-

1.	Chairman:-Director, ICAR-DGR, Junagadh-362 001, Gujarat.
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Members: Staff side

1.	Shri Y.S. Karia, Secretary-IJSC and Member CJSC.
2.	Smt. M.N. Vaghasia, Member
3.	Shri G.G.Bhalani, member-Retired
4.	Shri A.K.Maurya, Member-Transfer
5.	Shri B.J.Dabhi, Member
6.	Shri C.G.Moradia, Member

Members:- Office side

1.	Dr. R. Dey, Pr. Scientist, DGR, Junagadh.
2.	FAO, DGR, Junagadh.
3.	AO, DGR, Junagadh.

7. Contractual Staff

1	RA	02
2	SRF	02
3	YP-2	01
4	YP-1	15
5	High Skilled worker	01
6	Skilled Helper	02
7	Security Staff -Ex. Army	24



Finance and Accounts

Budget DGR Main Unit (Rs. in lakhs)

Budget Head	Allocation	Total Expenditure
Establishment charges	904.00	902.11
Wages	91.00	90.75
Administrative Expenses	239.15	239.13
Pension	239.39	238.91
T.A.	30.83	30.83
Research and Operational Expenses	161.68	161.68
HRD	2.48	2.48
Works	66.38	66.38
Equipment	45.53	45.53
Furniture	16.90	16.90
IT	2.35	2.35
Books	0.00	0.00
Vehicles	7.09	7.09
Other	1.80	1.80
Miscellaneous	15.86	15.86
TSP	30.00	0
TOTAL(Rs. in lakhs)	1854.44	1821.80

AICRP-G (Rs. in Lakhs)

Budget Head	Allocation	Total Expenditure
Pay & Allowance	618.21	617.96
TA		
Recurring Contingency & Need Based Research	191.33	191.18
TSP	40.00	21.46
TOTAL(Rs. in lakhs)	849.54	830.60



हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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