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DIRECTORATE OF RICE RESEARCH

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)
RAJENDRANAGAR HYDERABAD - 500 030

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PREFACE

The major mandate of the Directorate of Rice Research (former All India Co-ordinated Rice Improvement programme) is to co-ordinate multilocation testing of rice production technologies, research networks, organise strategic and applied research in the areas of irrigated rice eco-system and to facilitate exchange of germplasm and information Research programmes have been developed and organized to accomplish these objectives The Annual Report encompasses the various programmes and activities being undertaken and the results achieved through All India Co-ordinated Rice Improvement Programme, research networks and lead research in different disciplines, viz, Varietal Improvement, Agronomy, Soil Science, Plant Physiology, Entomology, Plant Pathology, Agricultural Engineering and Communication Training Centre The report is the outcome of the efforts of the scientists of DRR and co-operating centres located across the country

Operationally, the year was marked by several important mile stones involving more output oriented programmes During 1996-97 two improved varieties were released by central varietal release committee and 18 varieties were released by state varietal release committees Concurrently significant contributions were made in the developing eco-friendly technologies like integrated nutrient pest and disease management for sustainable crop production and protection

Efforts are continued to promote collaborative research programmes with National and International agencies Further, a perspective plan has been prepared by devising appropriate policies, plans and programmes which are quite relevant and forward looking for rice research and development Strong infrastructure base is being built up at the Directorate by procuring sophisticated equipments and modernising the research laboratories in order to keep pace with the up coming trends in rice science and technology

The material for this report was provided by the Heads of the Departments/Sections and Programme leaders by compiling the results of programmes and activities being undertaken during the year and I acknowledge with appreciation Heads of the Department/Section and all other scientists, administration, technical and supporting staff who put their efforts in preparation of this Annual Report of 1996-97

K Krishnaiah
PROJECT DIRECTOR

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SUMMARY

Directorate of Rice Research has developed over years an efficient mechanism for national level planning and executing multidisciplinary and multilocation testing DRR also facilitates exchange of genetical material and information across the country It conducts lead research for irrigated ecology through its research projects, 7 ad-hoc projects, organises four major research networks *Hybrid rice, Biotechnology, Quality rices and germplasm evaluation for biotic stresses*

BREEDING

Varietal release

Three varieties PKU 2R 281-PP-31-1 and Dhala Heera for rainfed uplands and one each ASD 20 and Sonamani for lowlands and saline areas respectively were identified by State Variety Release Committees Similarly 14 varieties Viz , Srikakulam Sannalu Bharant, Sravani, Swati Penna Kesava Siva Indur Samba, ASD 19, ADT 42, Co46 TPS 3, Syamala, CORH 1, CRM 40 and Tapaswani for state releases and Nidhi and Pusa 677-50 103 2-9 for Central releases were approved for irrigated areas during the year

Forty five promising varieties were identified for wider testing Of these 22 were for rainfed 14 for irrigated ecologies, while eight were for high altitude areas in the country IET 14131 a super fine aromatic rice was suggested for Basmati growing areas

The All India co ordinated varietal improvement programme included 27 national yield trials 2 national screening nurseries, 3 international yield trials and 8 international observational nurseries A total of 1 091 entries were evaluated at 464 trial sites involving 98 locations in 23 states representing the major ecologies Promising genotypes suited to different ecological situations with required duration were identified

Breeder seed production

A total of 41 released varieties suited for rainfed irrigated abiotic stresses (saline and alkaline, high altitude) and basmati growing areas were involved in breeder seed production which was organised at 23 centres in the country A larger quantity of 1272 quintals of seed was produced which is in excess of the Government of India target set for the year

HYBRID RICE

Four new promising hybrids KJT RH1 UPRH 27, PRH-1, HKRH - 1002 were identified and involved in on farm testing which had an yield advantage upto 2 tons Thirty promising hybrids have been identified from National Hybrid Rice Trials A dozen among them selected for on-farm trials include - ZRI 158 MPH 518 KMRH-2 UPRH 27, MTUHR 2040, TNRH 16, IR 62829 A/BR 827 35

BIOTECHNOLOGY

Programme is structured in the areas of (a) gene transfer and (b) gene characterisation (DNA marker technology)

Wide hybridisation Six new CMS lines viz , RPMS 1 1, RPMS 1 2, RPMS 1-3, RPMS 1 4, RPMS 2 and RPMS 4 were developed utilising *O nivara* and *O rufipogon* possessing the desirable floral traits such as higher stigma exertion and higher out crossing rate

Anther Culture Several doubled haploids (DH) induced from F1 hybrid anther culture did show 90% realisation of yield of F1 hybrid

It was also established besides genotypic effects cytoplasm also strongly influences anther response to culture

Rice' transformation Using Biolistic and Agrobacterium mediated transformation gene transfer protocols were developed Transient expression of introduced gus reporter genome is demonstrated and putative transformants are under further evaluation

DNA markers and gene tagging Genetic studies on resistance to gall midge had brought out presence of atleast five gall midge biotypes (GMBs) and seven putative genes imparting resistance The dominant gene conferring resistance (Gm2) to gall midge biotype-1 has been mapped to rice Chromosome 4 by RFLP and RAPD analysis A marker aided selection system is developed by conversion of RFLP markers into PCR based RAPD markers Gm3 (t) gene imparting resistance to same biotype (GMB 1) but non allelic to Gm2 is mapped to Chromosome 11

PHYSIOLOGY

Phenology growth and productivity of ten hybrids and two varieties sown at three different dates in the dry season of 1996 were compared The phenological development was more stable in hybrids but the decrease in grain number per panicle under later plantings was more in hybrids than in varieties The results indicate that the optimum date of planting for hybrids is earlier to that for varieties in the dry season

A field study in 1996 WS on reduction of panicle density on filled grain percentage in 8 hybrids and 2 varieties showed that reduction in panicle density of 70% of the control (274 + or - 30 panicles per M^2 at flowering) during grain filling phase did not improve filled grain per cent The results suggest that under normal condition assimilate availability may not be limiting the filled grain per cent

Experiments were conducted at 12 locations for understanding crop responses to abiotic stress conditions of upland and water logged ecologies, flowering dates of parental lines of rice hybrids and genotypes x environment interaction on growth and yield in irrigated ecology

Modern genotypes (IET 13170 and Tulasi) had higher crop and panicle growth rates and greater stem reserves during grain filling under mild water stress conditions than the traditional upland varieties The adverse effect of water logging stress on panicle number could be overcome by increasing plant density in direct seeded crop under water logged condition

The study on G x E interaction on phenology, growth and yield of irrigated rice revealed that variations in days to flowering and grain yields were more pronounced in early duration than in late duration cultivars

AGRONOMY

Integrated use of green manure/FYM with granulated 'N' inorganic fertilizers is a superior agronomic practice than that of prilled urea N on recommended 'N' basis to the first crop of rice as well as succeeding rice crop in terms of grain yield Conjunctive use of higher fertilizer dose with organic manures, particularly with green manure (Dhaincha) increased the apparent recovery of N and higher uptake of 'N and P' nutrients during rabi season in general, with granular fertilizers in particular

Higher chlorophyll index values were found only in flag leaf during flowering stage in various hybrids as compared to scented and high yielding varieties The correlation of SPAF-502 Meter values with colour chart was positive and significant Highest correlation (r=0 8) was recorded at panicle initiation stage of the crop

Developed a specific agronomic package of practices for hybrid and scented rice

Thin nursery with shallow planting gave the best results in terms of grain yield in HYVs similar to Hybrids

Butachlor + safener was found to be the best in controlling weeds and recorded comparable grain yields in direct sown rice under puddled conditions with two hand weedings

AGRICULTURAL ENGINEERING

Evaluation of direct seeders and transplanters for rice crop establishment Direct seeding of pregerminated paddy with row seeder eliminated the operations like nursery raising and transplanting saves labour and time facilitates line sowing to take up mechanical intercultural operations While the transplanter and manual transplanting needed 214 and 347 man hr/ha respectively the row seeder required only 8 man hrs to cover one hectare With row seeder there is a net saving (in cost of operation) of Rs 649/ha and 1080/ha as compared to that of transplanter and manual transplanting respectively The yield levels of Row Seeder is more as compared to manual transplanting

SOIL SCIENCE

Build-up of soil organic matter on account of combined use of organic (FYM, GM) and inorganic fertiliser sources over time was observed in the long-term study on soil fertility Dual use grain cum green manuring green gram was found superior as pre-rice crop in the trial on combined use of organic and inorganic fertilisers Linear response to applied Zn up to 100 kg/ha was observed in alkaline soil at Faizabad while at Mandya the response was curvilinear with maximum yield at 50 kg Zn/ha Maximum P response in irrigated soils was restricted to moderate dose of 20 kg P_2O_5/ha, while in uplands the response to applied P was at higher dose of 30 kg P_2O_5/ha Rice genotype Swarna was found to fare well both under N depriving and N abundant condition thus combining in it both N use efficiency and N responsiveness In contrast Vijeta was found to be highly N responsive variety lacking N use efficiency trait at zero applied N

Rice based cropping system Dual use greengram yielded grain on the average 4 99 Q/ha besides leaving behind 23 8 t/ha crop residues for incorporation Sunnhemp and dhaincha contributed relatively higher biomass of about 50 t/ha each The succeeding *kharif* rice receiving green manures gave higher grain yield over fallow (3 47 t/ha) Among the non-rice crops following *kharif* rice, groundnut was seen to benefited by daincha which contributed more soil organic matter Sesamum was observed to yield better in green manured plots as compared to fallow Sunflower and blackgram were not influenced by residual effects of *pre kharif* green manures Rotation of upland rice with bengal-gram in black soils resulted in doubling of *kharif* upland rice grain yields Higher yields of groundnut (1945 kg/ha) were observed over check (970 kg/ha) when gypsum was applied at 1 5 t/ha

Efficient N Management In mineralisation study involving urea, green manures and rice straw combined use of GM and urea increased N mineralisation rate by 31 56% Straw incorporation was not observed to cause any adverse effects either on N minerlisation/N release rate Under cyclic submergence where conditions exist for favourable gaseous N losses deep placement of urea super granules significantly increased N recovery (65%) uptake (128 kg N/ha) over urea (103 kg N) and GM + Urea (93 kg N/ha) Very early varieties like Prasanna and Aditya could recover N only from surface layers and thus respond well to applied N While late maturing Pranava and Salivahana could tap soil N from deeper layers too requiring relatively less fertiliser N In the long term experiment on the fertility management on a vertisol, the results of 12th and 13th crop showed that on the average rice responded not only to well established N but also to the supply P K and Zn over time

ENTOMOLOGY

Evaluation of elite cultures and hybrids from different screening nurseries revealed 54 promising cultures against BPH, 168 against WBPH and 58 both BPH and WBPH Screening of 337 entries against gall midge showed that 117 cultures recorded nil damage against biotype 1, while 92 entries showed nil damage against biotype 4 10 entries recorded nil damage against both biotype 1 and 4

Application of fipronil granules @ 75 g a i /ha and mitac spray @ 300 g a i /ha were effective against stem borer, gall midge and whorl maggot comparable to that of recommended carbofuran granular application and spray application of chlorpyriphos Application of Nimbicidine @ 4% a commercial neem formulation as an alternate spray checked the resurgence causing effect of deltamethrin spray against BPH

Efforts to exploit the natural biological control in rice ecosystem revealed that in situations of low to moderate pest incidence, unnecessary insecticide application sometimes practised by farmers can be avoided A single need based application of insecticides was enough to maintain yield levels as well as to ensure favourable balance of pest and natural enemy populations

Studies on monitoring of yellow stem borer through pheromones traps revealed that it was possible to identify peak occurrence of yellow stem borer at both vegetative and reproductive stages thereby indicating the potential for its use as an easy tool for decision making for pest control operations Use of pheromones in direct control of stem borer through pheromone mediated mass trapping on whole village basis (an area of 350 acres) revealed that pest incidence at heading stage as well as population of yellow stem borer at maturity was significantly low in pheromone treated areas compared to areas with farmers practices

Studies on performance of multiple resistant culture under protected and unprotected conditions revealed that IET 12875 possesses broad based resistance as well as stability in yield potential

Application of carbosulfan granules was effective in reducing the population build-up of root nematode *Hirschmaniella mucronata*, and its performance was comparable to that of carbofuran

PLANT PATHOLOGY

The national screening nurseries (6) comprising 1346 advanced breeding lines were evaluated against major rice diseases and entries with broad spectrum of resistance were identified In the adhoc research project on evaluation of rice germplasm for biotic stresses during 1996 3000 accessions received from Raipur were evaluated for blast and bacterial blight at DRR A few accessions were highly resistant to blast and bacterial leaf blight In another field test a few slow blasting resistant cultures were identified and the most promising were IR 64 IET 12863, 13188 and a few others

Among the new fungicides evaluated, none were comparable to Beam 75WP against blast However against sheath blight Opus 12 5 SC and Atemi 50 SL were highly effective Against false smut Blue Copper 50 and Chlorothalonil 40 were effective in reducing the disease

In pathogenic variability studies on BLB pathogen it was observed that pathogenic isolates of *x oryzae* isolated from wild rices habitats away from conventional rice field and as well as from cultivators fields in Andhra Pradesh has similar genetic make up suggesting that genetic flow must have occurred from wild rices to cultivated rices in different parts of the country Aggressiveness of *R solani* was evaluated on known susceptible and resistant rice cultivars It was observed that

fungus isolates from Kapurthala, Moncompu and Titabar were highly virulent than others It was observed that Silica application reduced disease severity and certain chemicals such as application of Salicylic acid (through seed soaking) reduced sheath blight severity

Integrated disease management trials conducted in different test sites of varied agro-climatic conditions indicated that host plant resistance coupled with need based fungicide application reduced significantly blast disease Also production constraints in 13 states were monitored and population variability of major rice pathogens blast, BLB were evaluated

COMMUNICATION AND TRAINING CENTRE

During the year 1996 97 in all nine need based and skill oriented training on various aspects of Rice Production Technology were organised A total number of 139 senior level extension functionaries from different state agricultural departments (SADs), technical and marketing executives from public and private sector agro input agencies (AIAs) were benefited by participating in the training programmes

सारांश

वर्षो से चावल अनुसधान निदेशालय का राष्ट्र स्तरीय योजना तथा बहु अनुशासनिक एव कई स्थानो मे जॉच कार्य के क्रियान्वयन हेतु एक सक्षम प्रक्रिया के रूप मे विकास हुआ है । चावल अनुसधान निदेशालय से देश के सभी भागो मे जनन साम्रगी तथा सूचना के विनियम की सुविधा भी हैं । यह अपने अनुसधान परियोजनाओ के माध्यम से सिचित पर्यावरण हेतु अग्रणी अनुसधान का आयोजन करता है । सात तदर्थ परियोजनाओ मे सकर चावल, जैवतकनीक, गुणवत्ता वाली चावल तथा प्रतिकूल जैवीय दशाओ हेतु जनन–द्रव्य का मूल्याकन नामक चार प्रमुख अनुसधान नेटवर्क है ।

पादप प्रजनन (Plant Breeding)

प्रजाति विमोचन

इस वर्ष के दौरान राज्य प्रजाति विमोचन समिति द्वारा वर्षाधारित ऊपरी भूमि हेतु पी के यू 2 आर 281–पी पी–31 तथा धल हीरा और निचली भूमि तथा लवणीय क्षेत्रो के लिए क्रमश ए एस डी 20 तथा सोनामनी किस्मो का चयन किया गया । इसी प्रकार श्रीकाकुलम सन्नालू, भारन्त, श्रावणी, स्वाति, पेन्ना, केशव शिवा, इन्दूर सम्बा, ए एस डी 19, ए डी टी 42, सी ओ 46, टी पी एस 3, श्यामला, सी ओ आर एच 1, सी आर एम 40 तथा तपस्वनी आदि प्रजातियों को राज्य विमोचन और निधि एव पूसा 677–50–103–2–9 का केन्द्र विमोचन हेतु अनुमोदन किया गया ।

व्यापक परीक्षण हेतु 45 उन्नत किस्मो का चयन किया गया । इनमे से 22 वर्षाधारित, 14 सिचित भूमि हेतु तथा 8 देश के अधिक ऊँचाई वाले स्थानो के लिए है । बासमती उगाने वाले क्षेत्रो के लिए आई ई टी 14131 (लम्बा एव सुगन्धित चावल) का सुझाव दिया गया ।

अखिल भारतीय समन्वित प्रजाति सुधार कार्यक्रम मे 27 राष्ट्रीय उपज परीक्षणो, 2 राष्ट्रीय परीक्षण नर्सरी, 3 अतराष्ट्रीय उपज परीक्षणो तथा 8 अतराष्ट्रीय अवलोकन नर्सरियो को शामिल किया गया । 23 राज्यो के 98 स्थानो मे शामिल 464 परीक्षणो द्वारा कुल ।, 091 प्रविष्टियो का मूल्याकन किया गया । विभिन्न पारिस्थितिक दशाओ के योग्य आवश्यक अवधि वाली उन्नत किस्मो का चयन किया गया है ।

प्रजनक बीज उत्पादन

वर्षाधारित, सिचित, प्रतिकूल अजैवीय परिस्थितियो (लवणीय, क्षारीय तथा अधिक उचाई वाली भूमि) तथा बासमती उगाने वाल क्षेत्रो के लिये कुल 41 किस्मो को प्रजनक बीज उत्पादन से शामिल किया गया जिसे देश के 23 केन्द्रो म आयोजित किया गया । 1272 कुन्तल बीज का उत्पादन किया गया जो भारत सरकार द्वारा रखे गये एक वर्ष के लक्ष्य से कही अधिक रहा ।

सकर चावल (Hybrid Rice)

के जे टी आर एच 1, यू पी आर एच 27, पी आर एच 1, एच के आर एच 1002 नामक चार नये सकर किस्मो का किसानो के खेतो मे परीक्षण किये जाने पर 2 0 टन प्रति है की अधिक पैदावार मिली । राष्ट्रीय सकर चावल परीक्षणो से 30 उन्नतिशील सकर किस्मो का चयन किया गया । जिसमे से लगभग एक दर्जन किस्मो को

किसानो के खेतो मे परीक्षण के लिये चुना गया जिनमे 2 आर आई 158, एम पी एच 518, के एम आर एच 2, यू पी आर एच 27, एम टी यू एच आर 2040, टी एन आर एच 16, आई आर 62829, ए/बी आर 827–35 प्रमुख है ।

जैव प्रौघोगिकी (Biotechnology)

इस कार्यक्रम को (क) जीन स्थानान्तरण तथा (ख) जीन विशेषीकरण (डी एन ए बाजार तकनीक) क्षेत्र के लिए तैयार किया गया ।

दूरस्थ सकरण आर पी एम एस 1–1, आर पी एम एस 1–2, आर पी एम एस 1–3 आर पी एम एस 1–4, आर पी एम एस 2 तथा आर पी एम एस 4 आदि छ नये सी एम एस लाईनो को जगली धान ओ निवारा तथा ओ रुफिपॉन (वाछनीय पुष्पीय गुणो जैसे अधिक पर परागण आदि) का उपयोग करके विकसित किया गया है ।

पराग कोष सवर्धन सकर (एफ–1) पराग सवर्धन से उत्पन्न की गई कुछ द्विअगुणित (डबल हैप्लाइड) किस्मो की उपज सकर के 90/ तक प्राप्त की गयी । पराग सवर्धन की सफलता प्रयुक्त किस्म के अलावा कोशिका–द्रव्य पर भी निर्भर करती हे ।

धान स्थातरण बायोलिस्टिक एव एग्रोबैक्टीरियम के प्रयोग से जीन स्थानान्तरण विधि का विकास कर लिया गया हे । प्रविष्ट गस रिपोर्टर जीनोम की क्षणिक अभिव्यक्ति का प्रदर्शन किया गया है और प्युटेटिव रुपान्तरो का आगे मूल्याकन किया जा रहा है ।

डी एन ए सकेतक तथा जीन चिन्हन गालमिज प्रतिगेधिता पर किये गये आनुवाशिक अध्ययन से इस कीट की पाच बायोटाइप एव प्रतिरोधिता प्रदान करने वाले 7 जीनो की उपस्थिति का पता लगाया गया हैं । गालमिज बायोटाइप – 1 के प्रति अवरोधी जीन (जी एम –2) को आर एफ एल पी तथा आर ए पी डी विशलेषण द्वारा चावल के गुणसूत्र–4 पर मानचित्रित किया गया है आर एफ एल पी सकेतको को पी सी आर पर आधारित सकेतको मे बदल कर "सकेतक द्वारा चयन" नामक प्रणाली का विकास किया गया हैं । गालमिज बायोटाइप –1 के प्रति एक भिन्न अवरोधी जीन जी एम 3 (टी) को गुण सूत्र –11 पर मानचित्रित किया गया है ।

पादप कार्यिकी (Plant Physiology)

अग्रणी अनुसधान

वर्ष 1996 के शुष्क मौसम मे तीन विभिन्न अवधियो वाले 10 सकर एव 2 अन्त प्रजात किस्मो की ऋतुजैविकी, वृद्दि तथा उत्पादकता की तुलना की गई । सकरो मे ऋतुजैविकी (फिनॉलॉजि) का विकास स्थिर पाया गया किन्तु देर से रोपाई करने पर सकरो मे अन्त प्रजात किस्मो की अपेक्षा प्रत्येक बाली मे दानो की सख्या कम पायी गयी । अत शुष्क मौसम मे सकर किस्मो की रोपाई अन्त प्रजात किस्मो से पहले की जानी चाहिये ।

वर्ष 1996 के खरीफ मौसम मे 8 सकर एव 2 अत प्रजात किस्मो मे कम बाली सघनता का बाली मे दानो के प्रतिशत पर किये गये अध्ययन से पता चला है कि दाने भरने की अवस्था मे चैक (274 + अथवा – 30 बाली प्रति वर्ग मीटर) की अपेक्षा 70/ बाली सघनता से बाली मे भरे दानो के प्रतिशत मे कोई वृद्दि नही हुयी । इससे यह निष्कर्ष निकलता है कि सामान्य परिस्थिति मे खाघ पदार्थ की उपलब्धता से दाना भरने के प्रतिशत मे कमी नही आती हे ।

उपरी भूमि एव जल ग्रहण क्षेत्रो मे प्रतिकूल अजैवीय दशाओ का फसल पर प्रभाव जानने एव सिचित क्षेत्रो मे सकर किस्मो के पेत्रिक वशक्रमो की पुष्पण तिथि व किस्म–वातावरण पारस्परिक प्रतिक्रिया का फसल वृद्दि एव उपज पर अध्ययन के लिये 12 स्थानो पर प्रयोग किये गये ।

पानी की थोडी कमी की अवस्था मे दाना भरने के दौरान आधुनिक किस्म (आई ई टी 13170 तथा तुलसी) मे पारपरिक ऊपरी भूमि की किस्मो की अपेक्षा अधिक उपज, बाली वृद्दि दर एव तने मे अधिक मात्रा मे खाघ पदार्थ सचित पाया गया । सीधे बोयी गयी धान की फसल मे जल एकत्रित होने पर बालियो की सख्या पर पडे प्रतिकूल प्रभाव को प्रति इकाई क्षेत्र पौधो की सख्या बढाकर कम किया जा सकता है ।

सिचित धान मे किस्म–वातावरण पारस्परिक प्रतिक्रिया का ऋतुजैवकी, वृद्दि एव उपज पर किये गये अध्ययन से पता चलता है कि पद्देती किस्मो की अपेक्षा अगेती किस्मो की पुष्पण अवधि एव उपज अधिक प्रभावित पायी गयी ।

सस्य विज्ञान (Agronomy)

धान की पहली तथा अनुवर्ती फसल मे "एन" के आधार पर साधारण (प्रिल्ड) यूरिया के स्थान पर दानेदार "एन" अजैविक खाद के साथ हरी खाद/एफ वाई एम का समन्वित उपयोग दाने की उपज की दृष्टि से एक उत्कृष्ट सस्य क्रिया हैं ।

साधारणत रबी मौसम के दौरान अधिक उर्वरक (विशेषकर दानेदार) के साथ जैविक खाद (हरी खाद जैसे ढैंचा) का प्रयोग करने से नत्रजन एव फास्फोरस तत्वो के अवशोषण स्तर मे सार्थक वृद्धि हुयी ।

पुष्पण अवस्था के दौरान सुगन्धित एव अधिक उपज देने वाली किस्मो की अपेक्षा सकर किस्मो की ध्वज पर्ण मे पर्णहरित की मात्रा अधिक पायी गयी । एस पी ए डी 502 मीटर के मान का रगीन चार्ट के साथ सहसबध धनात्मक तथा सार्थक रहा । फसल के पुष्पगुच्छ की प्रथम दशा मे उच्च सह सबध (आर=0 8) रिकार्ड किया गया ।

सकर तथा सुगन्धित चावल की खेती की उन्नत सस्य विधियो का विकास किया गया हैं । सकर चावल के समान ही अधिक पैदावार देनेवाली किस्मो मे भी कम सघन नर्सरी एव उथली रोपाई करने से अधिक पैदावार मिली ।

लेई युक्त (पडल्ड) खेत मे अकुरित धान की सीधी बुवाई करने की दशा मे ब्यूटावलोर + सेफनर (खरपतवारनाशी) खरपतवार नियन्त्रण मे श्रेष्ट पाया गया और इसकी उपज भी हाथ से 2 बार खरपतवार निकाले गये खेत के समान रही ।

कृषि अभियन्त्रिकी
(Agricultural Engineering)

चावल फसल की स्थापना हेतु सीधे बीजारोपण तथा प्रतिरोपण यन्त्रो का मूल्याकन

अकुरित धान के बीजो की पक्ति मे बुवाई करने वाली मशीन के प्रयोग से नर्सरी उगाने व रोपाई करने से छुटकारा एव समय तथा श्रम की बचत के साथ–साथ यान्त्रिक विधियो से फसल मे अन्त सस्य क्रियाए करना आसान हो गया । मशीन द्वारा अकुरित बीजो का एक हैक्टर मे पक्ति से बुवाई करने मे 8 मानव घण्टो की आवश्यकता होती है जवकि मशीन

व हाथ से एक हैक्टर की रोपाई करने मे क्रमश 214 एव 347 मानव घण्टो की आवश्यकता होती हैं । इस प्रकार मशीन तथा हाथ द्वारा रोपाई करने की तुलना मे क्रमश 649 रू एव 1080 रू प्रति हैं की बचत हैं । पक्ति मे बुवाई करने मे हाथा से रोपाई की तुलना मे पैदावार भी अधिक मिलती हे ।

मृदा विज्ञान (Soil Science)

मिटटी की उर्वरता पर लम्बी अवधि के अध्ययन से देखा गया कि लम्बे समय तक जैविक (गोबर की खाद एव हरी खाद) तथा अजैविक खादो के सम्मिलित उपयोग से मिटटी मे 100 कि जिक/है तक डालने पर रेखीय अनुक्रिया देखी गई जबकि मान्डया मे वक्र–रेखीय अनुक्रिया के साथ 50 कि जिक / है डालने पर अधिकतम उपज प्राप्त हुयी । सिचित मृदा मे फास्फोरस का अधिकतम प्रभाव इसकी औसम मात्रा 20 कि /है पर सीमित था जबकि भूमि मे फास्फोरस का अधिकतम प्रभाव 30 कि /है पर पाया गया है । धान की स्वर्णा किस्म नत्रजनकी कमी एव अधिकता वाली दोनो दशाआ मे अच्छी उपज देती हैं । जो इस किस्म की नत्रजन के प्रति अच्छी उपयाग क्षमता एव अनुक्रिया को सिद्ध करती हे । इसके विपरीत विजेता किस्म अत्याधिक नत्रजन सवेदी है जिसमे नत्रजन प्रयोग न करने की दशा मे उपयोग क्षमता शून्य पायी गयी ।

अग्रणी अनुसधान

द्विउददेशीय मूग की फसल से 4 99कु /है देने की पैदावार देने के अलावा 23 8 टन/है के फसल अवशेष के रूप मे मृदा मे मिलाने के लिये प्राप्ति होती हैं। सनई एव ढैंचा द्वारा परती मृदा (3 4 टन/है) के मुकाबले अधिक दाने की पैदावार प्राप्त हुयी खरीफ मे धान की फसल लेने के बाद अन्य फसलो मे मूगफली की फसल ढेचे द्वारा सर्वाधिक लाभान्वित हुयी जिससे मृदा को अधिक जेविक पदार्थ प्राप्त हुयी । तिल की पैदावार परती भूमि की अपेक्षा हरी खाद वाली भूमि मे अधिक प्राप्त हुयी लेकिन सूर्यमुखी एव उडद पर पूर्व खरीफ मे उगायी गयी हरीखाद की फसल का कोई प्रभाव नही पडा । चने एव उपरी भूमि के धान को बारी–बारी से उगाने पर धान की उपज दुगनी हो गयी । जिप्सम (1 5 टन/है) प्रयोग करने से मूगफली की उपज 1945 कि /है प्राप्त हुयी है । जबकि बिना जिप्सम के प्रयोग मे उपज 970 कि /है थी ।

प्रभावकारी नत्रजन प्रबन्ध

यूरिया, हरीखाद एव धान का भूसा, हरीखाद एव यूरिया का सयुक्त प्रयोग के अन्तर्गत खनिजीकरण के एक अध्ययन मे नत्रजन खनिजीकरण दर मे 31 56/ तक की वृद्धी हुयी । मिटटी मे भूसे के मिलाने से नत्रजन खनिजीकरण / स्राव पर कोई प्रतिकूल प्रभाव नही पडा । चक्रीय जलमग्नता के दौरान जिसमे नत्रजन का गैसीय रूप मे ह्रास होता हो तो दानेदार यूरिया का गहरायी पर प्रयोग करने से यूरिया (103 कि नत्रजन) एव हरीखाद + यूरिया (93 कि /है) की तुलना मे नत्रजन प्राप्ति (65/) व अशोषण (13 कि नत्रजन/है) पाया गया । अति–शीघ्र पकने वाली किस्मे जैसे प्रसन्ना एव आदित्या मृदा की केवल ऊपरी सतह से नत्रजन प्राप्त करती है । अत प्रयोग की गयी नत्रजन का भरपूर उपयोग करती हैं जबकि देर से पकने वाली किम्मे (प्रनवा एव सालीवाहन) मृदा की निचली सतह से भी नत्रजन प्राप्त करती है अत इनके लिये नत्रजन उर्वरक की कम मात्रा प्रयोग करने से भी काम चल जाता हैं । मृदा उर्वरता प्रबन्ध के एक

लम्बी अवधि के अध्ययन मे 12 वी एव 13 वी धान की फसल के परिणामो से पता चला कि नाईट्रोजन के अलावा पूर्व फसलो मे डाला गया फास्फोरस, पोटाश एव जिक भी फसल की उपज को प्रभावित करते हैं।

कीट विज्ञान (Entomology)

विभिन्न स्क्रीनिग नर्सरी से विशिष्ट प्रविष्टियो और सकरो के मूल्याकन से बी पी एच के प्रति 54, डब्लू बी पी एच के प्रति 168 और दोनो के प्रति 58 प्रविष्टियॉ अच्छी पायी गयी। गालमिल के प्रति 337 प्रविष्टियो का मूल्याकन करने पर यह पाया गया कि 117 प्रविष्टियो मे बायोटाइप–1, 92 प्रविष्टियो मे बायोटाइप 4 एव 10 प्रविष्टियो मे बायोटाइप 1 व 4 द्वारा कोई हानि नही पहुचायी गयी ।

दानेदार फिपरोनिल (75 ग्राम सक्रिय तत्व/ है) तथा मिटेक (300 ग्राम सक्रिय तत्व प्रति है) का प्रयोग तनाछेदक, गालमिज तथा वर्लमैगट के प्रति अनुमोदित दानेदार कार्बोफयुरान एव कलोरपाईरीफास के छिडकाव के समान प्रभावी पाया गया। बी पी एच कीट की डैल्यमेथ्रिन के छिडकाव से बढी सख्या को निम्बीसिडीन के 4/ घोल का छिडकाव करने पर नियन्त्रित किया जा सकता है ।

चावल पद्धति मे प्राकृतिक जैव नियत्रण का उपयोग करने से यह सिद्ध हो पाया है । कि कीटो के कम अथवा औसत आक्रमण की स्थिति मे किसान द्वारा कई बार कीटनाशी का छिडकाव करने की आवश्यकता नही है। तथा फसल मे केवल एक बार कीटनाशी का छिडकाव करके कीट के प्राकृतिक शत्रुओ की सख्या मे सही सतुलन बनाये रखने के साथ अच्छी उपज प्राप्त की जा सकती हैं ।

फेरोमान ट्रेप द्वारा पीले तनाछेदक की निगरानी पर किए गए अध्ययन से पता चलता हैं कि फसल की वानस्पतिक एव पुष्पण अवस्था के दौरान कीटो की अधिकतम सख्या उत्पन्न होने के विषय मे जानकारी प्राप्त की जा सकती हैं जिससे इसको कीट नियत्रण के निर्णय लेने मे एक प्रभावी साधन के रूप मे प्रयोग किया जा सकता हैं । सपूर्ण गाव (350 एकड क्षेत्र) के आधार पर फेरोमान के सीधे प्रयोग द्वारा तनाछेदक के नियत्रण से पता चलता हैं कि पुष्पण के समय कीट आक्रमण एव पकी फसल मे तना छेदक का आक्रमण किसानो द्वारा अपनाये गये तरीको की अपेक्षा फेरोमान प्रयोग किये गये खेत मे बहुत कम था ।

सुरक्षित और असुरक्षित हालात क अन्तर्गत किए गए बहु–प्रतिरोधी प्रविष्टियो के कार्यनिष्पादन पर अध्ययन स पता चलता है कि आई ई टी 12875 मे व्यापक प्रतिरोधिता के साथ–साथ उत्पादन क्षमता की स्थिरता व्याप्त हैं ।

दानेदार कारबोसुलफेन के प्रयोग से जडो मे रहने वाली नेमाटाड हिरसचमनेला मुकरोनाटा से बचा जा सकता है यह कीटनाशी कारबोफूरान के समान प्रभावी हे ।

पादप रोग विज्ञान (Plant Pathology)

धान की मुख्य बीमारियो के प्रति 6 राष्ट्रीय छटनी नर्सरी के अन्तर्गत 1346 अग्रिम प्रजनन प्रविष्टयो का मूल्याकन करने के बाद विस्त्रित वर्णक्रम (स्पोक्ट्रम) वाली प्रविष्टयो की पहचान की गयी । 1996 के दौरान तदर्थ अनुसधान परियोजना के अन्तर्गत धान के जनन द्रव्य (जर्म प्लाजम) का असामान्य जैवीय दशाओ के लिये रायपुर से प्राप्त की

गयी 3,000 एक्सेशन को चावल अनुसधान निदेशालय मे झोका एव जीवाणुज अगमारी के लिये मूल्याकन किया गया । परिणाम स्वरूप कुछ प्रविष्टियो को उपरोक्त दोनो बीमारियो के प्रति प्रर्याप्त प्रतिरोधी पाया गया । एक दूसरे क्षेत्र–परीक्षण मे झोका के प्रति कुछ कम प्रतिरोधी प्रविष्टियो का पता लगाया गया जिनमे आई आर 64, आई ई टी 12863, आई ई टी 13188 तथा कूछ अन्य प्रमुख हैं ।

परीक्षण किये गये फफूदीनाशियो मे से कोई भी झोका रोग के प्रति बीम 75 डब्लू पी के समान प्रभावकारी नही पाया गया । जबकि शीथब्लाइट रोग के लिये ओपस 12 5 एस सी तथा अटेमी 50 एम एल काफी प्रभावकारी सिद्ध हुये । नीला कापर 50 और वलोरोथेलोनिल 40 नामक फफू दीनाशक फाल्सस्मट बीमारी को कम करने मे प्रभावी सिद्ध हुये ।

बी एल बी रोगकारक पर रोगकारक विविधता अध्ययन मे यह देखा गया कि पैथोजनिक आईसोलेट मे जगली चावल से प्राप्त एक्स ओराईजी जो परम्परागत चावल एव आन्ध्र प्रदेश मे किसानो के खेतो से अलग रहता है दोनो मे एक ही प्रकार का आनुवशिक सघटन है । जिससे यह सिद्ध होता है कि देश के विभिन्न भागो मे जगली धान से कृषित धान की ओर आनुवाशिक बहाव रहा हो । आर सोलेनाई की आक्रामकता का चावल की ज्ञात प्रतिरोधी एव सवेदनशील किस्मो पर परीक्षण किया गया । यह देखा गया कि कपूरथला, मोनकोम्पू और टीटाबार से पथृक किए गए फफूद अन्य की तुलना मे अत्यत उग्र पाये गए । यह भी देखा गया कि सिलिका प्रयोग रोग को कम करता है तथा कुछ रसायन जैसे सेलीसिलिक एसिड का प्रयोग शीथ ब्लाईट की उग्रता को कम करता हैं ।

अलग–अलग कृषि जलवायु स्थितियो की विभिन्न परीक्षण स्थलो मे किये गये समन्वित रोग प्रबध प्रयोगो से ज्ञात हुआ है कि पोषी पौध प्रतिरोधिता एव आवश्यकतानुसार फफूदी नाशक के प्रयोग से झोका रोग को नियन्त्रित करने मे काफी सफलता मिली । 13 राज्यो मे उत्पादन बाधाओ का अवलोकन किया गया तथा झोका एव जीवाणुज अगमारी नामक रोग कारको की समष्टि की विविधता का अध्ययन किया गया ।

सचार और प्रशिक्षण केन्द्र
(Communication and Training Centre)

वर्ष 1996–97 के दौरान चावल उत्पादन प्रौघोगिकी के विभिन्न पहलुओ पर नौ आवश्यकता आधारित और कौशल उन्मुख प्रशिक्षण आयोजित किए गए । इस प्रशिक्षण कार्यक्रम मे विभिन्न राज्य कृषि विभाग से आए विस्तार कार्यकर्ता तथा मार्वजनिक और निजी क्षेत्र के तकनीकी ओर विपणन कार्यपालको सहित 139 वरिष्ट स्तर के आधिकारियो ने भाग लिया।

ABOUT THE INSTITUTE

Mandate

The Mandate of the Directorate of Rice Research (DRR) is as follows

* To Co-ordinate multilocation testing at national level to identify appropriate varietal and management technologies for all ecosystems
* To conduct strategic and applied research on all major thrust areas with special emphasis on irrigated rice
* To co-ordinate and monitor research networks relating to problems of national and regional priority
* To serve as a major centre for exchange of research material and information
* To impart training to subject matter specialists and researchers and develop innovative extension mechanisms for transfer

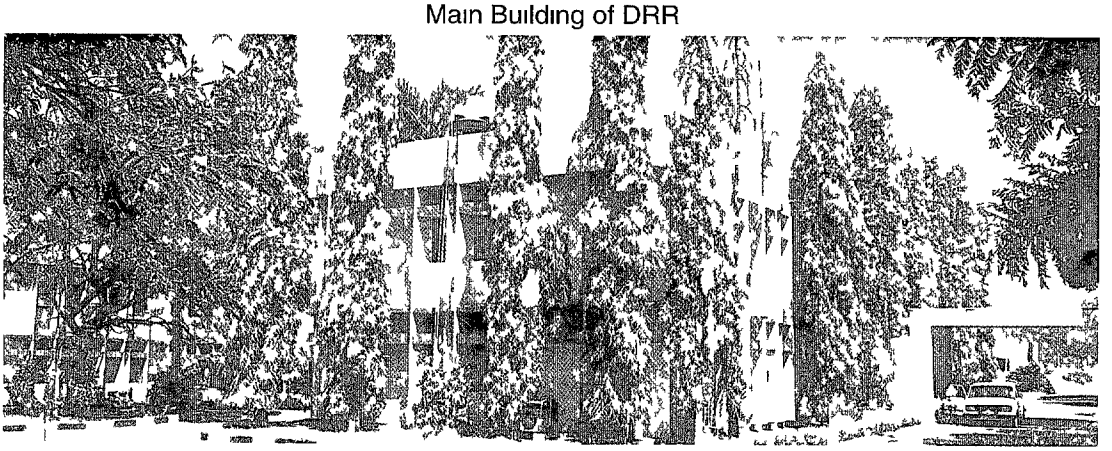
The All India Co ordinated Rice Improvement Project (AICRIP) was established at Hyderabad in 1965 by ICAR to organise Co ordinated Rice Research and national testing programme in India The project over the years had grown to present status as Directorate of Rice Research (DRR) from April 1985 with added mandate of organising research on irrigated rice for strengthening and stabilising rice production Under AICRIP there are 51 test locations funded by ICAR representing all states and all rice ecosystems In addition DRR is currently handling four major research networks on hybrid rice germplasm evaluation and utilisation quality rices and biotechnology and seven ICAR cess fund supported research projects

Infrastructure and facilities

With a view to fulfil its mandate effectively DRR is organised into following departments/sections at headquarters These are Plant Breeding, Agronomy Entomology, Plant Pathology, Plant Physiology Communication and Training Centre Biotechnology, Hybrid Rice Statistics and Agricultural Engineering The research programmes of DRR are supported by centralised services of Farm, Administration & Accounts Library Engineering and Agricultural Research Information System (ARIS) The budget of the institute and the scientific strength are given in the chapter administration and finance

The Directorate has well equipped laboratories, glasshouse and field facilities at Rajendranagar and Ramachandra Puram for applied and field oriented research in all the above disciplines The Directorate is endowed with Library Auditorium Seminar Halls Hostels and Guest House facilities for organising conferences, workshop and training programmes These facilities are shared by other local ICAR institutes/projects and Acharya N G Ranga Agricultural University (ANGRAU)

Main Building of DRR



WEATHER AND CROP SEASON

The local weather conditions are given in Table 1 During 1996 1997, India witnessed a favourable climate for rice production The country received normal south west monsoon rain during 1996 for the ninth time in succession Its distribution has been the best in the last five years By the end of the south west monsoon season (i e) September 32 of 35 meteorological sub divisions got normal to excess rains A few subdivisions deficient in rain were located in Vidarbha Orissa, Nagaland Severe drought has been reported in Orissa During the season there were 5 depressions over Bay of Bengal and Arabian Sea Two of these had developed into cyclones which affected the crop in the entire coastal Andhra Pradesh and parts of Tamilnadu The rice was grown in 42 91 million ha during the 1996 and the tentative production estimates were to the tune of 79 62 million tonnes There were no major pest epidemics during the year barring a few local problems in isolated region of the country e g stem borer in Punjab, gall midge in Kuttanad region bacterial leaf blight in Andhra Pradesh etc

Table 1 Mean monthly meteorological data at Rajendranagar 1996

Months	Temperature Max	Temperature Min	R H (%) I	R H (%) II	Rain (mm)	Sun shine (hrs)	Wind speed (km/hr)	Evapo (mm)	Rainy Day	Mean Temp
Jan 96	30 0	14 6	89	35	0 0	8 6	2 8	3 7	0	22 3
Feb 96	32 1	16 0	87	30	0 0	8 6	3 2	4 4	0	24 1
Mar 96	36 9	18 3	71	20	0 0	9 6	2 7	6 7	0	27 6
Apr 96	37 0	22 7	74	28	35 6	8 7	3 4	6 6	3	29 9
May 96	40 9	25 4	54	22	3 4	9 4	5 3	9 8	0	33 1
Jun 96	34 8	24 3	78	53	129 2	5 9	7 5	7 1	8	29 6
Jul 96	31 8	23 3	82	61	137 3	4 8	9 4	4 6	9	27 6
Aug 96	28 9	23 1	88	73	225 0	2 7	7 1	2 8	15	26 0
Sep 96	30 7	22 0	92	67	212 1	6 4	2 8	3 1	10 0	26 4
Oct 96	29 6	20 1	84	67	109 0	5 7	3 2	3 4	6 0	24 9
Nov 96	29 8	15 3	81	54	26 0	8 6	2 0	3 3	1 0	22 5
Dec 96	28 2	12 7	79	39	0 0	7 4	2 2	2 5	0 0	20 5
Mean	32 6	19 8	80	46	73 1	7 2	4 3	4 8	4 3	26 2

RESEARCH ACCOMPLISHMENTS

VARIETAL IMPROVEMENT

BREEDING AND GENETICS

Variety Releases

Three varieties PKU 2 R-281 PP 31 1 and Dhala Heera for rainfed uplands and one each, ASD 20 and Sonamani for lowlands and saline areas respectively were identified by various State Variety Release Committees Similarly for irrigated ecosystem 18 varieties and hybrids viz Srikakulam Sannalu Bharani Sravani, Swathi Penna, Kesava, Siva Krishna Hamsa (Fig 1) Indur Samba, ASD 19 ADT 42 Co 46, TPS 3 Syamala, CORH 1 CRM 40 and Tapaswani were identified as state releases while Nidhi and Pusa 677 50 103 2 9 as Central releases (Table 2) during the year

Varieties identified for wider testing in different ecosystems

Forty five promising varieties were identified for wider testing Of these, 22 were for rainfed 14 for irrigated ecologies while 8 were for high altitude areas of the country IET 14131 a super fine aromatic culture was suggested for Basmati growing areas (Table 3)

Co-ordinated Research

The All India Co ordinated varietal improvement programme included 27 national yield trials 2 screening nurseries, 3 international yield and 8 observational nurseries A total of 1 091 entries were evaluated at 464 trial sites involving 98 locations in 23 states representing the major ecologies Promising genotypes with appropriate duration suitable for different ecological situations were identified (Table 4)

Rainfed uplands Rice is grown under moisture stress in over 6 million hectares in the country Very early and early duration varieties are direct seeded under rainfed uplands in northern parts while grown as transplanted crop under meagre irrigation facilities from wells or tanks in south The most promising entries are IET Nos 14350, 13817, 14376, 13943 and 14314

Rainfed lowlands Lowlands are classified as shallow (upto 30 cm water depth), semi deep water (upto 100 cm) and deep water (> 100 cm) The entries IET Nos 14336, 14077 for shallow, 13901, 13120 for semideep and 10549 for deep water are among promising ones Efforts were continued to develop varieties ranging from shallow to deep water areas

Irrigated areas The most important and potential areas contributing to 65% of the rice production at national level are situated in irrigated ecology Improved genetic lines with high yield potential, tolerance to biotic stresses in the duration of 120-130 days were identified for different regions of the country The entries IET Nos 10565 14470 with mid early duration 14253, 14444 with medium duration were in top ranks IET 14131 with slender grains and kernel aroma was promising in Basmati areas

Saline-alkaline areas Considerable area is affected due to soil salinity/alkalinity in the coastal and irrigated areas Cultivars were developed with tolerance to coastal salinity with the tidal regime (6-10 mm hos/cm) inland salinity (pH > 7 0), sodic soils/alkaline

soils IET 13762 for alkaline and IET 13765 for alkaline/coastal saline areas were promising

Hilly areas For high altitude areas of Uttar Pradesh Himachal Pradesh Jammu&Kashmir and northeastern India where rice is grown under irrigated as well as direct seeded conditions several early and medium duration cultures were identified Among the entries tested IET Nos 13792 14176 for irrigated areas and 15046 for uplands were among top ranks

Japonica trial

The liberalisation of trade restrictions by Japan resulted in import of rice under GATT opened up new trade avenues for India to further raise its export quantum In initial variety trial five popularly grown japonica varieties of Japan were evaluated in 18 locations spread over hills and plains in India to identify suitable genotypes and regions which can give higher yields retaining the quality traits desired by the Japanese consumers Two years testing indicated Koshihikari as suitable for growing in both hills and plains Hiyokumochi for hills and Yamadanishiki for plains with higher productivity while retaining quality traits (Table 4)

Breeder seed production

A total of 41 released varieties suitable for rainfed irrigated abiotic stress prone and high altitude areas and basmati growing regions were involved in breeder seed production which was organised at 23 centres in the country 1272 quintals of breeder seed was produced which was in excess to the Government of India target set for the year (Table 5)

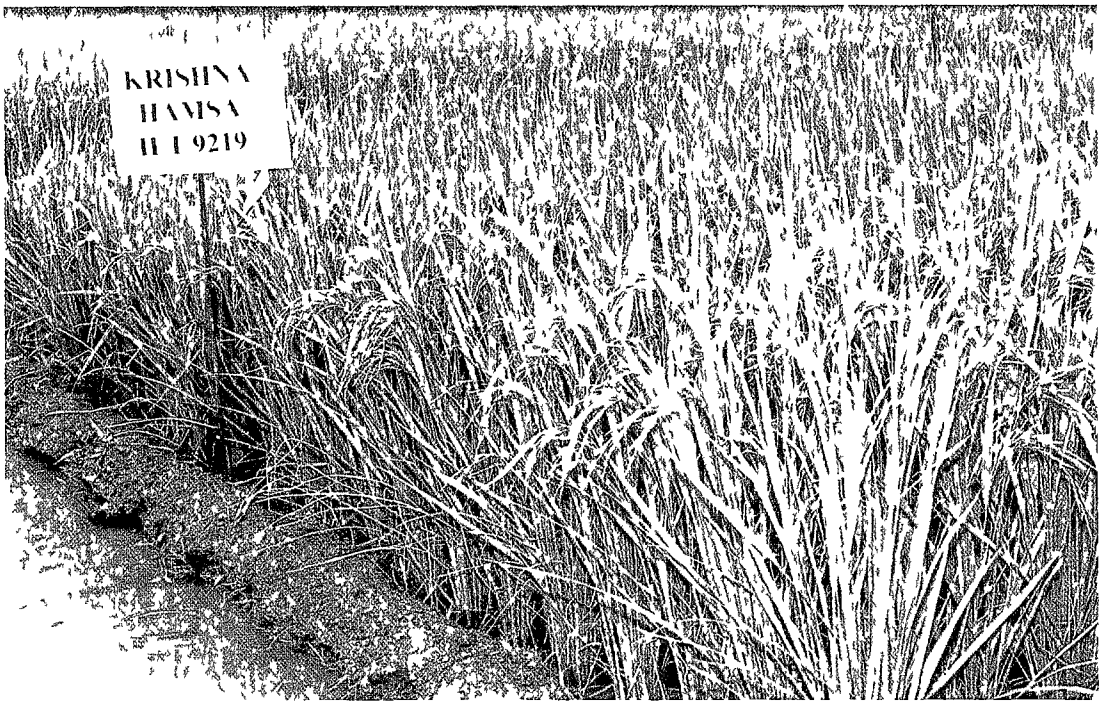


Fig 1 Krishna Hamsa A promising early duration variety

Table 2 List of varieties released during 1996-97

IET No	Variety name/ Designation	Days to 50% flow	Grain type	Reaction to pests/diseases	Areas Recommended
		CENTRAL RELEASES			
Irrigated Ecosystem					
9994	Nidhi	120	LS	R RTV	A P T Nadu Pondicherry West Bengal
12671/ 12693	Pusa 677 50 103 2 9	115	LS	R BL	Tamil Nadu M P (DS/TP)
		STATE RELEASES			
Irrigated Ecosystem					
	Srikakulam Sannalu	165	MS	R Bl GM4	Late planting in A P
	Vasundhara	130	LS	R RTV GM4	Andhra Pradesh
12630	Bharani	125	MS		Andhra Pradesh
	Sravani	120	LS	R Bl	Andhra Pradesh
11582	Swathi	125	MS	R Bl	Andhra Pradesh
	Penna	160	SB	R Bl GM SB	Andhra Pradesh
14002	Keşava	125	LS	R GM1 3	Andhra Pradesh
12799	Siva	130	LS	R Bl	Andhra Pradesh
9219	Krishna Hamsa	120	LS	GM1	Andhra Pradesh
	Indui Samba	125	MS	R GM	Andhra Pradesh
10436	ASD 19	125	MS	R Bl Tol Dr	Tamil Nadu (Pishanam)
13239	ADT 42	115	LS	R Bl BPH	Tamil Nadu (Kar Kuruvai)
	Co 46	125	LS	R BPH	Tamil Nadu (Samba Thaladi)
10522	TPS 3	140	SB	r bL bph	Tamil Nadu (Kar Kuruvai)
12561	Syamala	110	LS	MR GM	M P(wild rice menace for direct seed)
12561	CORH 1	115	MS	R GLH RTV	Tamil Nadu
12413	CRM 40	97	LB		Orissa
9945	Tapaswani	107	MS	R	Orissa
Shallow lowland					
	ASD 20	110	LS (Kar)	R SB LF Sh R	Tamil Nadu
Upland					
13971	PKU 2	105	MB	R BPH	Tamil Nadu Madhya Pradesh
12284	Poornima	80	LS		Madhya Pradesh
11411	Dhala Heera	55	LB	R GM GLH BPH Tol to drought	Orissa
Coastal salinity					
11365	Sonamani	122	SB		Saline areas of Orissa

Table 3 Promising varieties recommended for multiplication under testing during 1997

IET No	Designation	Days to 50% flow	Grain type	Reaction to pests/diseases	Areas Recommended
Rainfed upland					
13817	OR 165 86 12	66	LB		Direct seeded areas of Orissa
13818	OR 165 97 15	64	LB		Direct seeded areas of Bihar
13921	TM 1307	85	MS	Mod res to Bl BLB Sh Bl	TN Gujarat (transplanted)
13926	Pusa 836 702 208 207 7	87	LS		Karnataka Haryana (transplanted)
13831	JR 82 5 199	70	LB	Res to WBPH GM1 SB Bl	Karnataka (transplanted)
13832	JR 201	76	LS	Res to GM1 SB Bl	M P (direct seeded)
13636	KAU 8756	86	LB	Res to GM1 GM4	
13942	RP 1886 20463 1231	84	LS		TN
13943	OR 929 3 2	65	LB		Orissa W B (direct seeded)
13944	OR 930 1 1 2	67	LB		
13951	NDR 1025 3	77	LS		Eastern U P
Rainfed shallow water					
14074	RP 2332 165 63	116	LS		Karnataka
14077	RDR 8702	109	LB	Res to GLH BS	Karnataka
14080	NLR 33651	128	LB		TN A P
14089	RP 2542 201 1385	119	LB		A P
14100	OR 1206 25 1	125	LB	Res to Bl M P Assam	Orissa
14101	OR 1206 26 1	127	LB		Orissa W B Bihar
14105	CN 842 15 5	117	LS		Eastern U P W B
14107	CR 683 18	125	SB		Eastern U P Assam
Semi-deep water					
13120	NDR 4008	127	SB		U P Bihar W B
14208	NDR 4004	119	LB		U P

Contd

Table 3 Contd

IET No	Designation	Days to 50% flow	Grain type	Reaction to pests/diseases	Areas Recommended
Deep water					
10549	CN 271 14 3 53	115	LB		WB
Irrigated					
13570	HKR 91 113	105	LB		Punjab
13613	NDR 3011	108	MS	Res to GM5 MR RTV	Eastern U P
13762	CSR 88 IR 3	93	LS		Alkaline/inland saline areas
13765	CSR 88 IR 6	98	LS		Alkaline/Coastal saline areas
13993	HKR 93 1	94	LS		Haryana
14004	NLR 33655	102	LB	Res to GM1 GLH Bl	A P Karnataka
14018	UPRI 1425 1 4 1	101	LB	Res to Bl	TN Punjab Western U P
14019	UPRI 561 6 3	100	LB	Res to Bl(L)	TN Punjab Western U P
14031	OR 764 39	98	MS	Res to WBPH Bl	M P Assam
14032	OR 809 39	98	MS		U P M P
14038	R 5574 11	95	LB	Res to GM1 WBPH	U P M P
14058	RAU 456 54 2	108	LB		Bihar
14062	OR 1114 59	105	LS	Mod res to Sh R	WB Orissa
15065	KMRH 2	112	LS	Res to SB	Karnataka
Hill areas					
13459	UR 539 2	87	LS		Meghalaya
13482	HPR 976	90	SB		Himachal Pradesh Hills of U P
13483	VL 89 1167	96	LB		Hills of U P
13783	VR 435 3	96	LB		U P Meghalaya
13792	VL 90 1695	86	LB		Himachal Pradesh U P
14146	HPR 933	86	LB		Himachal Pradesh
Basmati growing areas					
14131	RP 3138 60 9 6 6	103	LS		Aromatic for Basmati growing areas

Table 4 Promising entries identified in different AICRIP trials *Kharif* 1996

Name of the trial	Promising entries (IET Nos)	Checks
Rained Upland		
AVE VE		
Direct seeded	14350 13817 13831 13832	Heera Aditya
Transplanted	14347 13831 13832 14345 14353	Heera Aditya
AVT E (Zone 1)		
Transplanted	14314 14928 13926 13921 14297	Annada Tulasi
AVT E (Zone 2)		
Direct seeded	14376 13943 14370 14371 13944	Annada Tulasi
Rainfed shallow water		
AVT SHW, Zone 1	14336 14077 14321	Salivahana Pranava
AVT SHW Zone 2	14100 14105 14419 14405	Salivahana Pranava
Semi deep water		
AVT SDW	13901 13120 14204	Sabita Utkal Prabha
Deep Water		
AVT DW	10549 14584 11875 11867 11871	Jalmagna
Irrigated		
AMT ME Zone 1	15065, 14276, 14290 14283 14274	Ratna Vikas
AVT ME Zone 2	14470 14032 14038 14457 14031	Ratna Vikas
AVT IM Zone 1	14253, 13570 14018 14004 14247	Jaya Suraksha
AVT IM Zone 2	14444 13613 14058 14062	Jaya Suraksha
AVT Basmati	14131, 14707 14720	Pusa Basmati 1 Taraori Basmati
IVT Non Basmati	15457 15449 15455 14875 14876	PR 106 IR 64 Samba Mahsuri
IVT Japonica	Hinohikari Yamadanishiki Koshihikari Gohyakumangoku Hiyokumuchi	Norin 18 Chingshi 15
Saline-alkaline soils		
Coastal saline	13762 13767 14200 13769 13768	CSR 10 Jaya Usar 1
Inland saline	15369 14659 15370 13762 13765	CSR 10 Jaya
Alkaline	13765, 13766 14659 13768	CSR 10 Jaya Usar 1
High altitude areas		
Irrigated		
AVT E(Hills)	13792 14158 14153 13789	Himdhan
AVT M(Hills)	14176 14180 13183 14169	Himdhan
Upland		
AVT UH(Hills)	15046 13459 14599 14598 13783	VL Dhan 221
Screening Nurseries		
NSDWSN	15240 15236 15222, 15237 15226	Sabita Utkal Prabha
NSASN	15394, 15395 15396 15397 15398	

Table 5 Variety-wise quantity of breeder seed allotted and produced during 1996-97

Variety name	Centres	Quantity (qtls) Allocated	Produced
Mahsuri	ANGRAU RAU KKVP IGKVV, Chinsurah, NDUAT, Nawagam NSC	20 25	58 1
IR 64	ANGRAU CRRI OUAT, TNAU KKVP, IGKVV Chinsurah NDUAT Sikkim NSC SFCI	73 70	161 35
Swarna	OUAT, KRIBHCO, NSC	61 60	175 50
Krishnaveni	ANGRAU	4 10	2 05
Samba Mahsuri	ANGRAU UAS SFCI NSC KRIBHCO	36 20	38 05
Tella Hamsa	ANGRAU UAS NSC	15 50	23 80
Kavya	ANGRAU	3 35	3 60
Surekha	ANGRAU	4 25	4 45
Jaya	DRR UAS KKVP AAU HAU, KAU R S Pura, Nawagam, SFCI NSC	46 35	65 91
Rasi	DRR UAS, Chinsurah KRIBHCO sfci	35 40	28 70
Phalguna	DRR, UAS, KRIBHCO	12 10	14 30
Swarnadhan	DRR	9 00	1 50
Kasturi	DRR	7 00	7 35
Aditya	DRR	1 10	
Tulasi	DRR IGKVV	14 00	2 10
Pusa Basmati-1	IARI	30 00	30 60
PNR-381	IARI, Chinsurah SFCI NSC	16 30	82 30
PNR-162	IARI	0 80	1 00
CSR 10	CSSRI	5 60	10 00
Ratna	CRRI OUAT KKVP Chinsurah, R S Pura SFCI NSC	25 05	26 60
Annada	CRRI OUAT, IGKVV, NSC	26 30	52 80
Kalinga III	CRRI, OUAT BAU IGKVV AAU KRIBHCO	52 80	46 95
Vanprabha	CRRI	6 00	2 40
Heera	CRRI OUAT RRSC, Sikkim	43 10	51 00
CR 1009	CRRI	13 00	11 00
CR 1014	CRRI	7 00	4 60
Lunisree	CRRI	3 50	5 70
IR 36	OUAT, KKVP, IGKVV Chinsurah, AAU KRIBHCO, SFCI, NSC	57 20	79 50

Contd

Table 5 Contd

Variety name	Centres	Quantity (qtls) Allocated	Produced
Lalat	OUAT	2 00	145 00
Sugandha	RAU	3 00	6 00
Rajashree	RAU	25 30	40 00
Jyothi	KAU, NSC	6 00	7 00
IR 20	TNAU UAS, NSC	17 40	16 80
IR 50	TNAU, AAU NSC	16 40	15 85
White Ponni	TNAU	4 80	-
ADT 36	TNAU	4 85	4 50
Intan	UAS	6 30	7 00
Basmati 370	KKVP, HAU PAU, R S Pura SFCI	4 70	7 40
Kranti	IGKVV	7 00	12 50
Pankaj	Chinsurah AU, NSC	2 80	3 30
Abhaya	IGKVV	9 00	16 50
Pantdhan 10	GBPUAT NSC	4 80	78 40
HKR 228	GBPUAT, NSC	2 40	22 30
Pantdhan 4	GBPUAT KRIBHCO NSC	13 20	250 00
Pantdhan 11	GBPUAT	1 00	5 50
Pantdhan 6	GBPUAT	1 40	168 00
Govind	GBPUAT	4 55	228 00
Sarjoo 52	NDUAT SFCI, NSC	5 20	119 00
NDR 118	NDUAT	1 45	20 00
Narendradhan 80	NDUAT NSC	3 10	18 00
Narendra 359	NDUAT	15 00	13 50
VL Dhan 221	VPKAS	0 50	0 50
PR 106	HAU PAU SFCI NSC	6 60	33 00
PR 103	PAU, NSC	6 30	9 80
PR 111	PAU, SFCI NSC	10 50	23 63
PR 108	SFCI	0 60	

ANGRAU = Acharya N G Ranga Agricultural University RAU = Rajendra Agricultural University KKVP = Konkan Krishi Vidyapeeth IGKVV = Indira Gandhi Krishi Vishwa Vidyalaya, NDUAT = Narendra Dev University of Agriculture & Technology NSC = National Seeds Corporation, CRRI = Central Rice Research Institute, OUAT = Orissa University of Agriculture & Technology, TNAU = Tamil Nadu Agricultural University, SFCI = State Farms Corporation of India KRIBHCO = Krishak Bharati Cooperative Limited UAS = University of Agricultural Sciences DRR = Directorate of Rice Research AAU = Assam Agricultural University HAU = Haryana Agricultural University KAU = Kerala Agricultural University IARI = Indian Agricultural Research Institute GBPUAT = G B Pant University of Agriculture & Technology, VPKAS = Vivekananda Parvatiya Krishi Anusandhan Shala

Genetic enhancement of quality rices

ICAR research network in genetic enhancement of quality rices for higher productivity and export was continued during 1996 involving 14 centres

In the multilocational testing programme IET 14131 (RP 3138 60 9 6 6) from the cross Pusa Basmati 1/Phalguna was identified as the best culture (Fig 2) This culture recorded yield advantage of 37 5% over Taroari Basmati the traditional check and was comparable to standard checks in all quality parameters It was rated as one of the most desirable culture in the panel test It was recommended for onfarm trials in traditional basmati growing areas (Table 6) Promising basmati entries include IET 14707 (HKR 93 40) and IET 14702 (88 H5 1 1 2) which are tall in stature and are on par with checks in all quality parameters Both cultures possess resistance to gall midge biotype 1 while the latter has tolerance to white backed planthopper also A selection from Basmati composite IET 13549 (RP ST 328) has consistently out yielded Pusa Basmati 1 by 1 t/ha and Taroari Basmati by 2 3 t/ha The culture has tolerance to leaf blast bacterial leaf blight and stem borer and was found to be suitable for making parboiled Basmati rice which has high demand in the international market

Fig 2 IET 14131 A promising dwarf scented variety

A total of 830 elite lines were evaluated in 21 observational, preliminary and advanced station trials at 10 centres The entries which combine key quality traits with high yield potential are as under

Entries with quality traits and yield potential at 11 centres

Centre	Entry
Kapurthala	PAU 2343 and PAU 2122
Kaul	HKR 91-455, HKR 92 455
IARI	Pusa 1280 7 4, Pusa 1283 3 19
Pantnagar	UPR 1854 14 1, UPR 193 104
R S Pura	RR 501
DRR	LST 121 LST 103
Banswara	IET 13550
Siriguppa	SIRI 436
Raipur	Madhuri Selection 11 R 6 36 405
Faizabad	NDR 6072, NDR 637
Nellore	NLR 33958 NLR 5166 14-3-3

At DRR 76 cultures including checks were evaluated for yield and quality during *Rabi* and *Kharif* One culture RP 3120 (RP 2691/ Kasturi) with desirable quality traits significantly out yielded Kasturi and Pusa Basmati 1 in yield while 7 other cultures (Table 7) from RP 3238 3120 3376 3135 3949 and 3120 were promising with significant yield superiority over Taroari Basmati

One thousand eight hundred and twelve lines in F4 F5 generations from 36 crosses and 747 lines in F6 F7 generation from 8 crosses were evaluated for desirable quality traits grain yield and leaf blast This led to identification of 320 bulks and 1481 single plant selections Quality analysis resulted in a good number of aromatic selections exhibiting high kernel length after cooking (12 14 mm 14 16 mm and >16 mm) The most promising material include RP 3392 3695 3644 3145 3654 3659 3624 and 3120 (Table 8)

A total of 285 fresh crosses were made to transfer important quality traits into dwarf high productive background at all centres

Use of mutation tool at Varanasi led to the development of 13 long slender grained dwarf mutants of Basmati 370 and Type 3 exhibiting high yield potential

In a study at DRR, the relationship of hull content on milling quality traits of scented rices revealed significant association between hull weight and milling recovery indicating that selective breeding for low hull content would enhance the total milled rice yields

At Ludhiana using D^2 analysis 33 scented rices were evaluated for genetic diversity and were made into 19 groups based on 8 characters

In the non-basmati quality rice trials IET 15457 (RP 3120 10-12) IET 14857 (PR 111) IET 14876 (NLR 33359) IET 15449 (R 405 44) and IET 14887 (RP 3125-90 85 2) possessed desirable quality traits besides superiority in yield Like-wise IET 14074 14333 14089 13926 14274 and 14329 were also found to possess high head rice recovery of over 60% and intermediate gelatinization temperature in other irrigated trials

Released varieties were analysed for key quality traits Varieties with good to high head rice recovery attractive appearance and highly desirable range of starch characteristics include IR 64 Krishna Hamsa PR 106 and Prakash in long slender Kavya Krishnaveni Samba Mahsuri Sona Mahsuri, Kamini Tulasi and White Ponni in medium slender Kushal and Radha in the short bold groups Medium slender types were associated with high milling and desirable cooking and eating quality traits (Table 9)

Table 6 Performance of IET 14131 in the co-ordinated trials, 1996

Quality traits	IET 14131	Pusa Basmati 1	Taroari Basmati
Grain yield (kg/ha)			
TBL	3225(38)	3650	2346
NBL	2997(10)	3107	2730
HRR (%)	59 3	61 0	49 6
KL	7 15	7 59	7 05
L/B ratio	3 99	4 39	3 94
Alkali value	7 0,7 0	7 0 7 0	6 2,6 2
KLAC (mm)	15 1	15 3	13 0
ER	2 11	2 02	1 84
AC (%)	23 9	24 6	22 8
Grain chalkiness	OC	VOC	VOC
Aroma	SS	SS	SS

Figures in parentheses indicate percentage improvement over Taroari Basmati

TBL = Traditional Basmati locations NBL = Non Basmati locations

HRR = Head rice recovery KL = Kernel length L/B = Length/breadth ratio

KLAC = Kernel length after cooking ER = Elongation ratio AC = Amylose content SS = Strong scent OC = Occasionally present VOC = Very occasionally present

Table 7 Details of selections made in promising crosses (F5) in pedigree nursery based on kernel length after cooking DRR 1996

RP No	LST No	Cross combination	Yield (Kg/ha)	Days to 50% flow	KL (mm)	KLAC (mm)	Aroma
3120	121	RP2691/Kasturi	+3113	106	8 15	14 7	SS
3238	103	PB1/IET8585	+2447	106	6 62	14 8	SS
3120	107	RP2691/Kasturi	+2575	108	6 96	12 3	SS
3361	111	Kasturi/RP2632 198	+2447	97	7 18	13 5	SS
3376	116	IR841 85 1 1 2/ R Basmati	+2447	98	6 99	14 3	SS
3135	118	PR 109/Pak Basmati	+2857	95	7 04	13 9	SS
3149	120	PB1/IET13548	+2739	102	6 97	15 2	SS
3120	127	RP2691/Kasturi	+2578	97	7 12	12 4	MS
		PB1	+2708	108	7 44	15 8	SS
		Kasturi	1935	90	7 18	12 3	SS
		Basmati 370	1935	97	6 59	13 3	SS
		Karnal Local	1817	92	7 39	13 5	SS
		Experimental Mean	2291				
		C D (0 05)	275				
		C V (%)	14 7				

KL = Kernel length KLAC = Kernel length after cooking SS = Strong scent
[1] Superior to PB 1 + Superior to Kasturi

Table 8 Details of selections made in promising crosses (F5) in pedigree nursery based on kernel length after cooking, DRR, 1996

RP No	Cross combination	Grain length (mm)			
		12 14	14-16	>16	Total
3392	IET 11341/Kasturi	14	13	14	41
3695	IR 64/R Basmati//R Basmati	71	32	5	108
3654	IR 36/IET 10654	13	3	8	24
3644	PB 1/IET 12603	34	21	9	64
3659	PB 1/Kasturi	17	8	4	29
3145	PB 1/IR 36	24	19	-	43
3624	IR 64/Bas 385	21		7	28
3120	RP 2691/Kasturi	90		-	90
3121	RP 2695/PB 1	28	5	-	33
3122	RP 2695/Kasturi	17	-	-	17

Table 9 Analysis of key quality traits of the released varieties

Variety	HRR (%)	KL (mm)	L/B	Alk Val	VER	WU (ml)	AC (%)	Grn Chalk
			LONG SLENDER					
IR 64	50 5	6 49	3 24	3 3	3 2 4 0	140	22 1	VOC
Saleem	59 0	6 28	3 01	4 9	4 3 3 8	250	27 5	VOC Trans
IR 30864	60 0	6 19	3 64	4 4 4 4	3 8	190	27 1	VOC Trans
Prakash	49 1	6 28	3 07	5 3 4 6	3 7	250	24 3	OC
Krishna Hamsa	58 8	6 38	3 50	3 7 3 7	3 8	140	23 9	VOC Trans
PR 106	61 5	6 63	3 25	7 0 7 0	4 3	265	22 7	VOC
			LONG BOLD					
Pothana	63 2	6 10	2 96	3 1 3 1	3 8	190	26 8	OC
			MEDIUM SLENDER					
Samba Mahsuri	60 5	4 75	2 58	4 3 4 9	3 8	140	2 9	A
Sona Mahsuri	63 5	5 12	2 58	4 3 3 9	3 5	110	25 2	A
Ambica	61 0	5 31	2 91	3 8 3 8	4 3	140	25 7	VOC Trans
Pantdhan 4	59 0	5 70	2 59	4 2 3 4	4 7	140	27 8	P
Kavya	70 0	5 98	2 74	4 9 4 7	4 0	190	23 5	VOC,Trans
Ranjit	65 6	5 26	2 60	5 3 5 4	4 3	100	25 8	A
M 72	66 3	5 47	2 87	2 8 2 8	4 3	140	24 1	A Trans
Kamini	61 2	4 83	2 77	4 3 3 7	3 8	150	23 9	VOC Trans
Tulasi	55 6	5 81	2 83	3 9 3 3	5 0	120	23 3	OC
Krishna Veni	66 0	5 68	2 96	4 8 3 8	4 0	150	24 5	VOC
White Ponni	55 5	5 29	2 67	4 8 4 6	3 8	130	24 9	OC
			SHORT BOLD					
Kushal	65 2	5 06	2 21	5 2 5 3	3 5	100	25 1	OC
Radha	54 3	5 34	2 47	4 9 4 0	3 8	110	24 8	OC
Moniram	58 0	5 41	2 47	5 2 5 3	3 7	120	26 3	OC

P Present A Absent OC Occassionally Present VOC Very Occasionally Present Trans Translucent

Promising entries resistant to pests/ diseases

The breeding program was oriented towards identifying genotypes to distinct agroecological situations in different regions of the country The pest complex as it exists either during wet/dry seasons was given major emphasis Through crossing and selection under field and greenhouse for resistance promising cultures were identified

In the early duration group, IET 9219 (Rasi/Fine Gora) was found to be resistant to blast and tolerant to cold during seedling stage It performed well in Telangana regions of Andhra Pradesh during *Rabi* season and was released as Krishna Hamsa (Fig 1) by SVRC as a replacement to Tella Hamsa, a predominantly grown variety In the medium duration group

IET 12875 which was identified for release as Triguna (Fig 3) by VIC as promising for Andhra Pradesh and Maharashtra is being tested in frontline demonstrations in East Godavari IET 12875 was also found resistant to gall midge biotype-5 prevalent in Kerala with reported damage upto 8000 ha in Kuttanad area during of Kerala 1996 97

Cultures originating from 40 crosses which were earlier screened under greenhouse conditions for resistance to major pests were evaluated in field and a few cultures were found promising and were superior to the check Phalguna The entries were entered in national trials (Table 10 and 11)

Another local trial was organised involving entries among 364 fixed cultures (F5-F6) in two replications The cultures were derived from crosses made among cultures possessing resistance to individual gall midge biotypes Selections were made both under field and greenhouse conditions The promising cultures (Table 12) from this trial would be evaluated in national trials

Genetics of resistance

Gall midge The varieties resistant to gall midge biotype 1 were studied for their nature of resistance reaction and were classified as hypersensitive positive and hypersensitive negative In both cases, the varieties showed resistance to gall midge However, the nature of resistance differed Genetic background of the nature of resistance was studied in some crosses with respect to hypersensitive reaction in intercrosses involving resistant types as well as susceptible ones and hyper-sensitive positive seemed to be controlled by dominant genes (Table 13)

Blast Six indica donors (Carreon Dular, Tetep Tadukan, Zenith and CNM 4140) and a susceptible check (Co 39) were screened against IC 9 race All the donors showed resistant reaction Crosses were effected in 2 groups in order to study allelism between resistance genes 1 Susceptible X Resistant 2 Resistant X Resistant The resulting 15 F1 and 15 F2 population was scored for disease reaction and data was subjected to Chi square test for goodness of fit In the first group (susceptible x resistant), resistance was dominant over susceptibility A single dominant gene governs blast resistance in all donors (3 resistant 1 susceptible) In the second group (resistant x resistant) resistance was dominant over susceptibility Resistance genes present in Carreon and Tetep are allelic with each other Two non allelic dominant and duplicate genes were found to be present in the donors Dular Tadukan, Zenith and CNM 4140

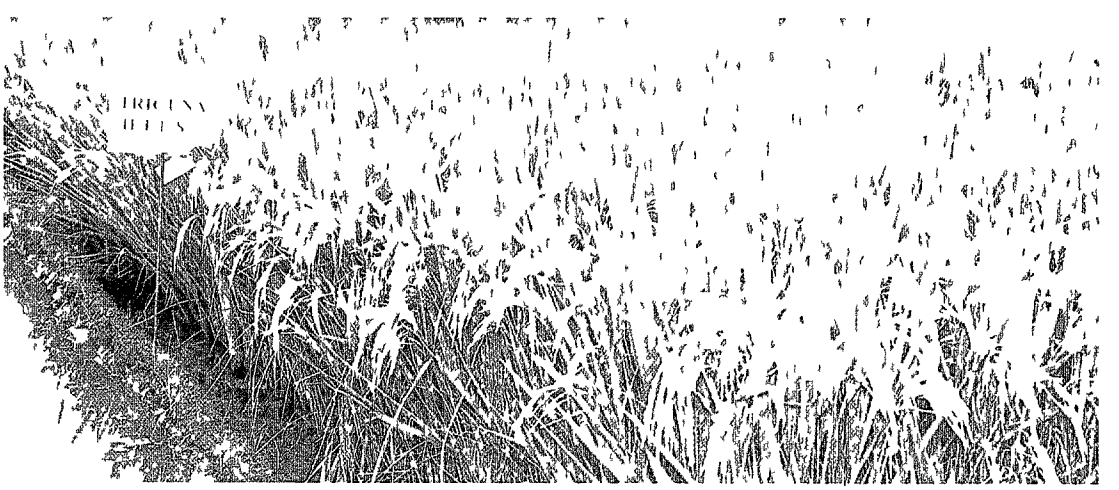


Fig 3 Triguna A Promising gall midge and BPH resistant variety

Table 10 Promising entries with resistance to multiple pests/diseases in *Kharif* 1996

Designation	Cross combination	Yield (t/ha)	Days to 50% flow	Grain type	Resistant to
RP31741549 1633	IET8655/IET8642	6 2	109	LS	BPH MR WBPH SB GM1 5 GLH
RP 2547 1322	ARC5723/ARC6650//RP1579 38	6 3	112	LS	GM1 WM
RP 3206 3205	IET7946/IET10267	6 2	115	LS	BPH
RP 3422 30885	T1432/L152//Suraksha	6 5	120	MS	BPH WBPH
RP 3206 32605	Prasanna/Suraksha	5 9	114	LB	WBPH
RP2542 12777 1831	IET5656/RP1579 GMS38	5 7	126	LS	BPH WBPH
RP3169 32295 1849	Tulasi/Nagarjuna	7 0	126	MS	BPH WBPH
RP2542 26789	IET5656/RP1579 GMS38	6 5	126	LS	BPH GM1 2 3 4
RP3746 26738	RPT26738/IET5656	6 2	120	MS	BPH WBPH SB GM1 4 LF
RP3804 23019	IET7946/RP1579 9700	6 4	120	MS	GM1 2 4 GLH BPH WBPH SB Hispa
RP 2542 13998	IET5656/RP1579 37	7 5	110	LS	BPH WBPH GMB 1 Bl
Phalguna	Check	5 9	120		

Table 11 Promising multiple resistant cultures with mid early and medium duration

Designation	Cross combination	Yield (t/ha)	Days to 50% flow	Grain type	Resistant to
RP 3165 1380	IET 7302/Suraksha	6 0	103	LB	MR BPH GM1 5
RP 3791 35 1669	RPW6 17/ ARC6650 19/ IET8585	6 7	103	LB	MR BPH WBPH
RP2932 32711 1887	IET 7302/Phalguna	6 2	107	LS	WBPH GM1 5 SB
RP 1888 1788	RP 79 5/TELLA VADLU	6 8	104	LS	MR BPH WBPH SB LF
RP 3790 1784	IET 7564/IET 7946	5 9	105	MS	BS
RP 1579	RPW 6 17/ARC 6650 1319	6 2	105	MS	BS
RP 12769	IET 7302/IET 6262	6 6	100	LS	RTV BPH WBPH GLH
Jaya (Check)		5 8	103		

Table 12 Promising cultures resistant to different biotypes of gall midge *Kharif* 1996

Designation	Cross combination	Yield (t/ha)	Days to 50% flow	Grain type	Resistant to
RP 2941 30308	IET 7302/Phalguna	6 4	122	MS	GMB 1 2 5
RP 3791 1827	RP1579Ri 17/IET8585	6 2	116	MS	GMB 2 5
RP 2542 12777 1832	IET5656/RP1579GMS38	7 1	112	MS	GMB 2
RP 3403 32319 1852	RPW6 17 W 1263	6 3	122	LS	GMB 2
RP 2941 32357 1857	IET 7302/Phalguna	6 7	122	LS	GMB 2 5
RP 2931 32387 1860	Phalguna/C 506	5 9	120	MS	GMB 1 2 5
RP 2931 32394 1861	Phalguna/C 506	5 8	126	MS	GMB 1 2 5
RP 3187 32591 1879	IET 7946/IET 6315	6 6	126	LS	GMB 4
Phalguna (Check)		5 8	120	LS	GMB 1

Table 13 Phenotypic segregation of F1 F2 seedling reaction for nature of resistance to rice gall midge

Cross	F1	F2 Reaction				
		HR+	HR	hro	Ratio	X^2
TN1 x Siam 29 (hro) (HR+)	(HR+)	400		159	3 1	3 40
TN1 x Phalguna (hro) (HR+)	(HR+)	150		68	3 1	1 30
TN1 x NHTA (hro) (HR)	(HR+)		226	82	3 1	0 05
TN1 x Banglei (hro) (HR+)	(HR+)	144		46	3 1	0 06
TN1 x Agannı (hro) (HR)	(HR)		100	35	3 1	0 01
NHTA 8 x Agannı (HR) (HR)	(HR)	All plants resistant with HR				
Siam 29 x Phalguna (HR+) (HR+)	(HR+)	250	0	0		No segregation
Phalguna x Banglei (HR+) (HR)	(HR+)	192	0	0		No segregation
Phalguna x NHTA 8 (HR+) (HR)	(HR+)	160	90	20	9 6 1	2 20
NHTA 8 x Banglei (HR) (HR+)	(HR+)	110	60	10	9 6 1	1 10

Germplasm Evaluation Raipur germplasm was evaluated and among these 36 entries registered high yield, ACC 22193 was the top yielder followed by ACC 22195, Bhada 7 Luchai (R 4696) ARC 10646 GP 208-1 and Khitidhan Among the characters studied the most prominent include semi-tall plant type green-sheath pigmentation and foliar colour medium culm thickness medium flowering duration low-tiller number semi-open panicle shape, moderate panicle exertion, medium panicle length apiculum pigmentation at flowering absence of awn moderate shattering, straw hull, white kernel colour and bold-grain shape In the other set of 3000 germplasm, 30 cultivars were found to be promising and some of them such as INRC Nos 6480, 6244, 6624 6575, 6630, 6612, 6302, 7695 and 7582 were better yielders In this set 19 lines were found to be profuse tillering 22 cultivars had long panicle (27 30 cm) type and 12 had fine grain type

Twenty five accessions showed better performance in upland condition and some of them INRC Nos 33905 7410 5289 5158 5269 and 5328 were promising 12 cultivars such as INRC Nos 6770 6771 8185 6815 8737 7032 8754 7059 8119d 8102 8120 and 8411 were found to be tolerant to alkaline condition (PH 9 4 9 8) In respect of wide adaptability Benigiri and Kaprvela reasonably performed well Similarly, INRC Nos 6770, 8185 6815 and 6771 performed well in both lowland and alkaline soil and yield and tolerance index in alkaline soil ranged from 91 to 83 percent and INRC 7023 showed wide adaptability in upland and alkaline soil (Table 14)

Table 14 Traditional rices showing wide adaptability

INRC No	Name	Source No	Height (cm) (cm)	EBT	Panicle Length (cm)	Panicle weight (g)	Grain yield/plant (g)
Upland vs Lowland			L U	L U	L U	L U	L U
5181	Benigiri	B12951	109 97 (89)	7 5 (71)	26 18 (69)	17 13 (76)	13 10 (77)
5792	C496		102 70 (69)	10 7 (70)	18 19 (105)	20 12 (60)	15 7 (54)
8841	Kaprvela	K2121	104 68 (65)	5 4 (80)	23 21 (91)	15 10 (67)	13 7 (54)
7188	Dhoud	D180	90 86 (96)	8 5 (63)	21 20 (95)	17 10 (59)	15 7 (47)
Lowland Vs Alkaline Soils							
6815	Gada Khuta	G31	100 62 (62)	6 5 (83)	23 18 (78)	22 20 (91)	18 15 (83)
8102	Sultu Gurmatia	S631	98 60 (61)	9 3 (33)	24 17 (71)	18 7 (39)	17 10 (59)
6771	Dudh Mani	D344	87 66 (76)	9 3 (33)	21 20 (95)	20 7 (35)	18 15 (83)

Abiotic stress tolerance

Varietal improvement programme continued for developing genotypes for abiotic stresses with emphasis on salinity/alkalinity in irrigated ecosystem

During the year 258 germplasm lines from different states 2 013 from INRC collection were screened under field conditions and promising lines identified The germplasm which showed high level of alkalinity tolerance at vegetative and grain filling were INRC Nos 8737 7032 8185 6815 8754 7059 8119 8102, 6770 6771 8120 and 8411 Among them INRC No 6770 (Dudhanani 1) and 6771 (Dudhamani 2) were very high yielding types While INRC Nos 6815, 6770 8102, 6771, 8185 and 7032 had wider adaptability as they exhibited high yield potential in normal as well as in alkaline conditions A few donors identified were utilised in breeding programme and 677 advanced lines (F4) from 34 crosses were evaluated and 24 cultures were found promising Further selection of 266 progenies in F2 F3 and 186 in F3 F4 were made from 54 crosses for evaluation A total of 363 F3 progenies from 18 crosses were evaluated and 394 selections were made (Table 15)

Table 15 Selection in F3 population of different crosses in normal and low P conditions

	Normal condition		Low P condition	
Cross	F3 lines	Plants selected	F3 lines	Plants selected
Jaya x IR 64	48	37	32	42
Jaya x CSR 10	8	22	18	32
Jaya x VL 206	10	12	23	46
Jaya x Tella Hamsa	8	13	16	12
Jaya x Pusa 169	11	21	18	10
IR 64 x CSR 10	23	47	25	32
IR 64 x Pusa 169	13	10	17	8
IR 64 x Sasyasree	38	42	20	36
IR 64 x VL 206	15	18	16	8
IR 64 x Tella Hamsa	20	28	22	15
IR 36 x CSR 10	15	22	20	34
IR 36 x Vikas	30	37	25	18
CSR 10 x Tella Hamsa	12	21	16	13
CSR 10 x Pusa 169	38	44	26	19
CSR 10 x VL 206	15	12	11	6
Tella Hamsa x Vikas	20	15	25	16
Tella Hamsa x VL 206	11	8	13	16
Tella Hamsa x Pusa 169	14	27	20	31

HYBRID RICE

Hybrid rice project operates as a research network with 12 centres across the country and is being co-ordinated by the Directorate

Evaluation of Hybrids

Hybrids released Two hybrids viz DRRH 1 and KRH 2 were released for commercial cultivation in Andhra Pradesh and Karnataka by the respective state variety release committees The salient features of these hybrids are given in Table 16

Thus so far totally seven hybrids have been released by the respective state variety release committees for cultivation in Andhra Pradesh Karnataka Tamil Nadu and West Bengal states Additionally 7 8 hybrids are also being marketed by the private seed sector The total quantity of hybrid rice seed produced during 1995-96 *rabi* season was 1300 metric tons and it was estimated that during 1996 *Kharif* season hybrid rice was cultivated over more than 50 000 ha

On-farm verification trials The hybrids found promising in Multilocation National Hybrid Rice Trials were evaluated in on farm verification trials Yield potential is estimated in a large area of 2000 m^2 or more Critical observations on incidence of disease/pests as well as the opinions of the farmers regarding acceptability of grain quality and other relevant factors were collected During the period under report seven promising hybrids identified were extensively evaluated in the farmers fields The summary results are presented in Table 17

Table 16 Salient features of released hybrids

Hybrids	Parentage	Duration (days)	Yield in OFT(t/ha) Hybrid	Check	Adv over check (t/ha)	%	Recommended Regions
DRRH 1	IR 58025A/ IR 40750	125 130	7 30	5 50 (Tellahamsa)	1 80	32 7	Telengana & Rayalaseema of A P
KRH2	IR 58025A/ KMR 3	130 135	7 40	6 10 (Jaya)	1 30	21 3	Irrigated regions of Karnataka

Table 17 Performance of promising hybrids in on farm trials

Season/Location	Hybrid	No of Trials	Mean Grain Yield (Kg/ha) Hybrid	Check	Advantage
***Rabi* 1995-96**					
Mandya	KRH 2	27	8647	7056 (Jaya)	1591
Chinsurah	CNRH-3	100	7700	5500 (HYV)	2200
***Kharif* 1996**					
Gujarat	DRRH-1	10	4109	3102 (GR 11)	1007
Mandya	KRH 2	39	8120	6822 (Jaya)	1298
Chinsurah	DRRH 1	3	5533	4667 (Jaya)	866
Karjat	KJTRH-1		7700	5200 (Jaya)	2500
Western U P	UPRH27	2	6798	6219 (PD4)	579
	PRH-1	3	6241	6219 (PD4)	22
Eastern U P	UPRH27	3	6599	4341 (PNR381)	2258
	PRH-1	14	5098	4341 (PNR381)	757
Karnal	HKRH-1002	4	7525	6612 (IR 64)	913

Totally 205 on-farm trials (127 during *rabi* 1995-96 with 3 promising hybrids in 2 states 74 trials with 5 promising hybrids during *Kharif* 1996) were conducted Performance of the hybrids DRRH-1 KRH 2, KJTRH 1 and CNRH-3 was promising with an yield advantage of 1 0-2 0 t/ha over the respective check varieties The hybrid PRH 1 recorded an average yield advantage of around 0 7 t/ha in eastern Uttar Pradesh and no advantage in Western Uttar Pradesh whereas the hybrid UPRH 27 had an yield advantage of 2 2 t/ha in eastern Uttar Pradesh The yield advantage observed in Western U P was around 0 5 t/ha

National yield trials To ascertain the extent of yield superiority in hybrids one of the recently developed hybrid KMRH-2 was evaluated along with the other promising advanced breeding inbred lines in Advanced Varietal Trial (AVT IME Zone I) along with 21 promising inbred lines and 3 checks at 16 locations across 11 states The results obtained are given in Table 18

The hybrid KMRH-2 ranked first in seven locations with an yield advantage ranging from 986 to 3417 kg/ha over the highest yielding check variety On the overall mean of 16 locations the hybrid had an yield advantage of 811 kg/ha over highest yielding inbred test variety and 1404 kg/ha over the highest yielding check

Five National Hybrid Rice Trials were conducted (two trials in *rabi* 1995 96 and three trials during *Kharif* 1996) Totally 116 hybrids were evaluated in these trials and more than 30 hybrids have been identified as promising at different locations A few promising hybrids (Table 19) will be evaluated in on farm trials during the ensuing seasons

Table 18 Performance of Rice Hybrid KRH 2 in Advanced Variety Trial (*Kharif* 1996)

Location	State	Grain Yield (Kg/ha)		
		Hybrid	Check	Advantage
Coimbatore	Tamil Nadu	5381	4395	986
Pondicherry	Pondicherry	5814	3222	2592
Mandya	Karnataka	10246	8962	1284
Rajendranagar	A P	7111	5259	1852
Sakoli	Maharashtra	5769	4691	1078
Nawagam	Gujarat	6400	4466	1934
R S Pura	J & K	5722	2305	3417
Mean	—	6635	4757	1878
Overall Mean	—	6203	4799	1404
Overall Mean	—	6203	5392*	811

* Highest yielding inbred line

Table 19 Some promising hybrids identified in National Hybrid Rice Trials (*Rabi* 1995 96 *Kharif* 1996)

2RI 158	MTUHR 2040
MPH 518	MTUHR 2037
3RI 086	TNRH-16
3RI 160	CNRH-2
KMRH 2	IR62829A/BR 827 35
UPRH 27	IR62829A/BR 736 20
HKRH 1003	

Identification and Development of Parental Lines For identification of the prospective parental lines, 225 test crosses were evaluated at DRR, Hyderabad Frequency of restorers was found to be 40% whereas that of maintainers was around 20% Among the identified restorers and maintainers some of the promising restorers are being utilised for production of experimental hybrids In the backcross nursery, several potential maintainers with desirable floral traits are being converted into new CMS lines Twenty maintainer lines are at different stages of backcrossing Overall in the Hybrid Rice Research Network centres 48 new CMS lines have been developed, and 160 genotypes are at different stages of back-crossing at the various centres

Diversification of Sources of Male Sterility Six new CMS lines viz RPMS1 1 RPMS1-2 RPMS1 3 RPMS1 4 RPMS2 and RPMS4 were developed utilizing three new sources of male sterility inducing cytoplasm from *O nivara* and *O rufipogon* All these lines possess desirable floral traits such as higher stigma exertion and higher outcrossing rate Out of the six new CMS lines all are highly stable except RPMS2 The panicle exertion problem, encountered in WA based CMS lines was not observed in these new sources By utilizing these new CMS sources, promising improved lines are being converted into CMS line (Table 20)

Two-line heterosis Breeding The major limitations of three line approach viz ,availability of only a few stable CMS lines with good outcrossing and high combining ability, restricted choice of male parents to only restorers need for use of maintainers for seed multiplication and negative effects associated with use of sterility inducing cytoplasm have prompted the initiation of research efforts on two line system of heterosis breeding Several thermo sensitive genic male sterile (TGMS) lines identified induced and those obtained from IRRI have been characterised for critical sterility point (CSP) and critical fertility point (CFP) Preliminary evaluation of experimental two line hybrids has indicated that these hybrids possess 5 10% enhanced heterosis as compared to the three line hybrids

Two line inter sub specific hybrids, involving indica and tropical japonica types were developed and preliminary evaluation was done Standard heterosis observed in these hybrids was in the range of 3-64% Spikelet fertility observed in hybrids was above 70% These hybrids had long panicles (> 25 cm) with approximately 250-300 spikelets per panicle Four of the six hybrids were found to be talls Seeds of two promising hybrids identified are being produced in large quantity to conduct a multilocational replicated yield trial of two line in inter sub specific hybrid in the ensuing seasons Genetics of TGMS character was studied by crossing TGMS lines with normal genotypes F2 segregating generation was grown in sterility inducing temperature regime Segregation for fertility and sterility observed was in the ratio of 3 1, indicating that TGMS character in these lines is controlled by single recessive gene

Table 20 Transferring new CMS source into elite breeding lines

Backcross generation	Number of lines under conversion	CMS Source	Important lines
BC-3	4	MS 577 A	Jaya, Samba Mahsuri
BC 2	3	MS 577 A	IR 64, IR 58025B, IR 66
BC 2	2	*O rufipogon*	IR 58025B, Suraksha
BC 1	6	MS 577	IR 40750 Ajaya, Suraksha Tellahamsa
BC 1	3	*O rufipogon*	IR 62829 B, CMS 22 B
BC 1	2	*O nivara*	M Vijaya IR 58025 B

BIOTECHNOLOGY

I Anther Culture in Rice Improvement

Genetic analysis of anther callus induction using a set of four parental diallel crosses involving high responding japonica cultivar Taipei 309 and three high yielding semidwarf indica cultivars IR72, IR64 and IR54 was carried out The genetic components of variation variance and covariance were estimated for testing the adequacy of additive dominance model of gene action The anther callus response was as high as 25 8% in Taipei 309 (japonica) whereas in indica varieties IR72, IR54 and IR64 it was only 5 97, 4 73 and 2 77% respectively, the least responsive being IR64 All F1 hybrids with Taipei 309 as one of the parents showed intermediate response (9 37 13 53%) On the contrary indica x indica hybrids were low responding and close to IR64 parent A graphical analysis of the relationship between variance (Vr) and parent offspring co-variance (Wr) in respect of anther response to callus induction is depicted in Fig 4

The regression coefficient (b=1 24) which was significantly different from zero but not from unity indicate the absence of epistasis Interception of regression line on Wr axis above the origin indicate the partial dominance of the trait The distribution of low responding indica parents IR64 IR54 and IR72 near the origin indicate that these possess dominant alleles for low response to callus induction Taipei 309 located farther from the origin may have recessive alleles for high callus response Thus genetic components of variation obtained from diallel study suggest that anther culture response appears to be governed by atleast a group of recessive genes High heritability estimates for callus induction suggest the transferability of this trait from japonica variety Taipei 309 to indica parents, and further confirms the early fixable additive component of gene action governing the anther response to callus induction

Variation in the regenerants from callus culture is not uncommon Androclonal variation was observed in respect of several morphological parameters such as, plant stature, earliness etc , in the anther derived plants, besides alterations in the ploidy levels and other chromosomal changes

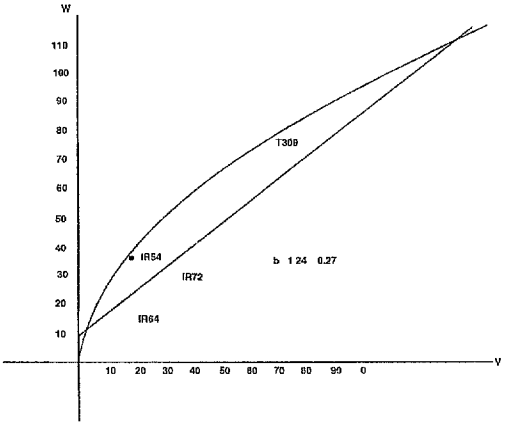


Fig 4 Anther callus induction in a 4 x 4 diallele

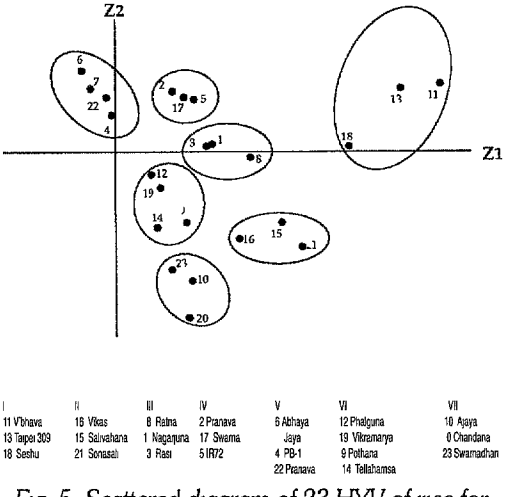


Fig 5 Scattered diagram of 23 HYV of rice for their in vitro response

Performance of selected androclones from two inbred cultures Taipei 309 (J) and IR72 (I) were field evaluated for agronomic characters (Table 21) One of the androclones of IR72 (AC42) recorded nearly 15% increase in the mean yield Two other androclones AC35 and AC36 derived from Taipei 309 showed yield increment of 3-5 percent over the parent The coefficient of variation among the androclones for most of traits was much less than that in the parents Cryptic variations observed among the androclones for several agronomic traits indicate involvement of minor genes that were responsible for decrease or increase in mean values of the trait Further stringent field evaluation of selected androclones would indicate the genetic worthiness of such vari ants produced in anther cultures

II Genetic Transformation

Systemic analysis of callus induction and re generation

Critical evaluation was done for three important parameters a) frequency and rate of callus induction and proliferation b) regeneration frequency and c) regenerants per callus and was subjected to multivariate analysis Based on D^2 analysis of these parameters the genotypes could be grouped into seven clusters (Fig 5) It is clear from these studies that there exists a wide variation among the genotypes with respect to in vitro response The values arrived by Canonical roots method indicate that the parameters contributing towards such variation are in the order of i) plants per unit culture ii) culture forming shoot buds and (iii) the appearance of green regions It was concluded that the regeneration is the limiting factor for in vitro response of genotypes Two indica genotypes - Vibhava and Seshu fall in the same cluster as Taipei 309 a japonica type and can be used for in vitro genetic manipulation studies

Agrobacterium mediated transformation

Transformation studies were initiated using tissue culture responsive cultivars such as Seshu Vibhava Taipei 309 Rasi and IR72 using the Agrobacterium strain LBA4404 containing pTOK233 Transgenic plants expressing gus and hygromycin resistance were obtained in case of Taipei 309 The putative transformants were further confirmed by Southern hybridization (Fig 6)

Table 21 Field evaluation of Androclones (*Rabi* 1996)

Genotype	Plant Height (cms)	Productive Tillers (No)	Grains/ Panicle (No)	Spikelet Fertility (%)	1000 grain weight (gms)	Yield/ Plant* (gms)	Yield advantage (%)
AC35 T309	105 4±2 4	7 9±1 5	138 3±6 3	93 4±1 8	24 1±0 1	22 8±1 2	5 39
AC36 T309	104 4±3 7	8 4±0 74	143 6±5 2	93 3±1 0	24 1±0 3	22 3±2 4	3 01
AC49 T309	106 3±4 2	7 8±1 0	132 8±0 5	91 5±1 7	24 2±0 3	20 6±2 7	4 17
AC40 IR72	82 7±2 8	11 5±0 2	89 8±10 6	81 7±2 8	21 2±0 4	16 0±0 9	7 94
AC42 IR72	83 8±3 5	12 5±1 9	93 8±8 3	82 9±3 6	20 0±0 1	17 2±0 8	14 51
Taipei309 (P)	104 6±3 6	7 0±0 5	134 1±6 8	93 3±2 2	23 4±0 7	21 6±4 2	
IR72 (P)	76 0±0 7	10 3±0 5	90 4±12 0	71 0±3 8	21 3±0 4	14 7±0 4	

Means±SD *Based on average of 20 plants/plot

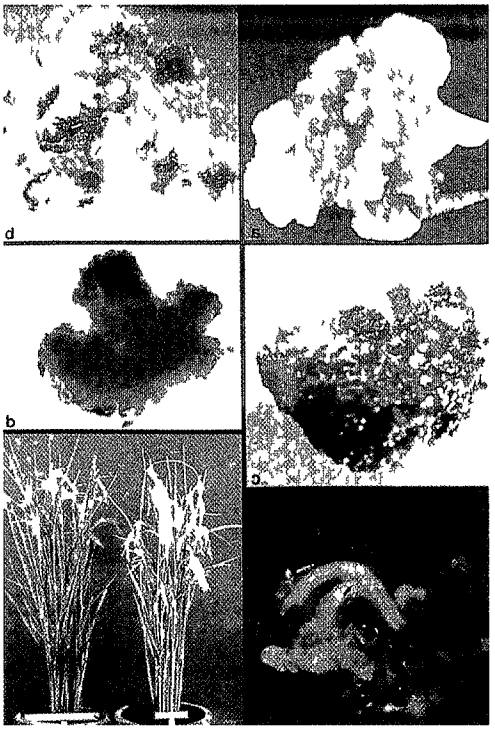


Fig 6 Agrobacterium tumafaciens mediated transformation of CV Taipei 309 using LBA 4404 p TOK 233

It has been established that isolated shoot meristem of monocots including rice can be infected and transformed using *Agrobacterium* This explant can rapidly regenerate into plant and circumvent the genotypic recalcitrance often confronted in tissue culture Shoot apices of Taipei 309 and 9313 a tropical japonica variety were used for *Agrobacterium* co cultivation Selection was done on hygromycin and survival rates were established on the basal medium was four concentrations (0 01 0 1 0 5 and 1 0 mg/l) of hygromycin It was found that no untransformed shoot apices survived on 0 5 1 0 mg/l hygromycin and hence 0 5 mg/l hygromycin was chosen for selection The surviving hygromycin resistant plants were tested for gus expression Transient gus expression was observed in some of the regenerants (Fig 7)

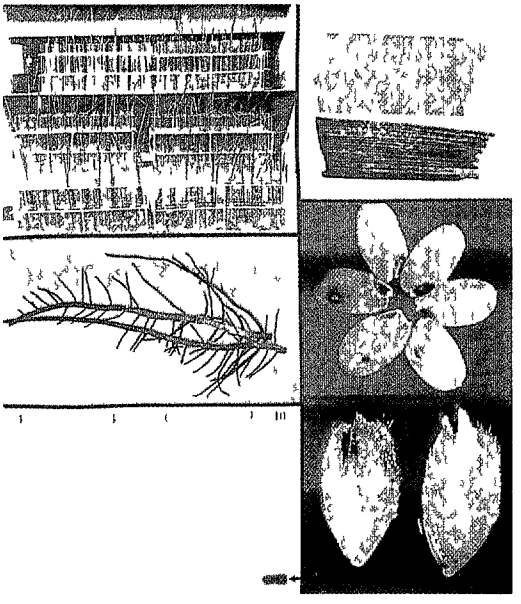


Fig 7 Gus histochemical staining of different plant parts

Biolistic transformation

Standardisation of protocol for biolistic transformation was continued by assaying the gus gene expression histochemically Various parameters and variables tested include (i) flight distance of micropojectiles (ii) microprojectile particle size (iii) concentration of DNA and (iv) helium pressure The flight distances (distance between the stopping screen and target tissue) of 8 and 16 cm were tested The nearer one (8 cm) was observed to give higher number of calli having transformation foci as well as the total number of foci per plate No significant difference was observed between two particle sizes 1 μ and 1 6 μ Of the four concentrations (5 8 10 12μg) of purified plasmid DNA tried though differences were not significant the percent calli having blue foci and cluster of blue spots appeared more when 5μg DNA was used Various target cells and tissues suspension cells immature embryos rachilla callus young (15 20 d) and old (60-70 d) primary calli from mature seed embryos were tried for biolistic transformation Seed derived calli showed selective advantage over other

explants due to ease of induction and handling Transformation efficiency of young calli was low and selection using marker gene was found to be more difficult as the calli were compact not permeating selection agent, resulting in escapes or else the calli turned brown when cut in to smaller units In contrast, 60-70d old primary calli could easily be disassociated there by facilitating better selection and efficiency in transformation (Table 22)

Using the leads from japonica variety Taipei 309 transformation system for indica genotypes Seshu and Nargarjuna was established The retention of regeneration capacitance among the transformant calli was however found difficult after 3 4 cycles of selection in many of the genotypes To overcome this problem rachilla derived callus was used for bombardment A few regenerants obtained are under test for stable transformation

Both bar and hygromycin resistance genes were used as selectable markers using glufosinate ammonium and hygromycin B as the selection agents Stable transformation could be obtained on hygromycin B but not on basta Difference in sensitivity of genotype to the selection agents was also apparent In the genotypes Seshu Vikas and Vibhava the gus gene expression was observed even after four weeks of bombardment but the rate of proliferation of callus was low compared to Taipei 309

Table 22 Transient gus expression in young and old calli from different rice genotypes

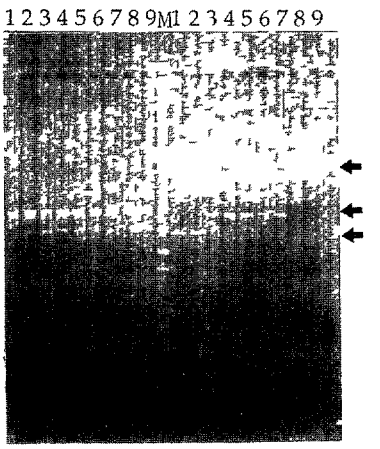
Genotype	Callus Young (15 20 d)	Callus Old (60 70 d)
Taipei 309	++	+++
Rasi	+	+
Vikas	++	++
Seshu	+	+++
Vibhava	+	++
Nagarjuna	NT	+++

NT Not tested + Low ++ medium +++ high

III Molecular Marker Technology

Identification of parental lines in hybrid rice RAPD fingerprinting

DNA from nine commonly used parental stocks (two cms lines IR58025A and IR62829A their isonuclear maintainer lines IR58025B and IR62829B and five elite restorer lines IR40750 IR29723 IR9761 IR34686 and IR10198) was extracted and amplified by Polymerase Chain Reaction (PCR) using 20 arbitrary decanucleotide primers Random amplified products were analysed on agarose gel and scored for polymorphism in amplification products With selected primers (OPA 7, OPA 12 OPA-20 OPB-19, OPU 17 and OPW-4) sufficient polymorphism could be detected to allow identification of individual stocks (Fig 8) The isonuclear maintainer and cms lines were however indistinguishable



With OPS 2 and OPS 4 Primers

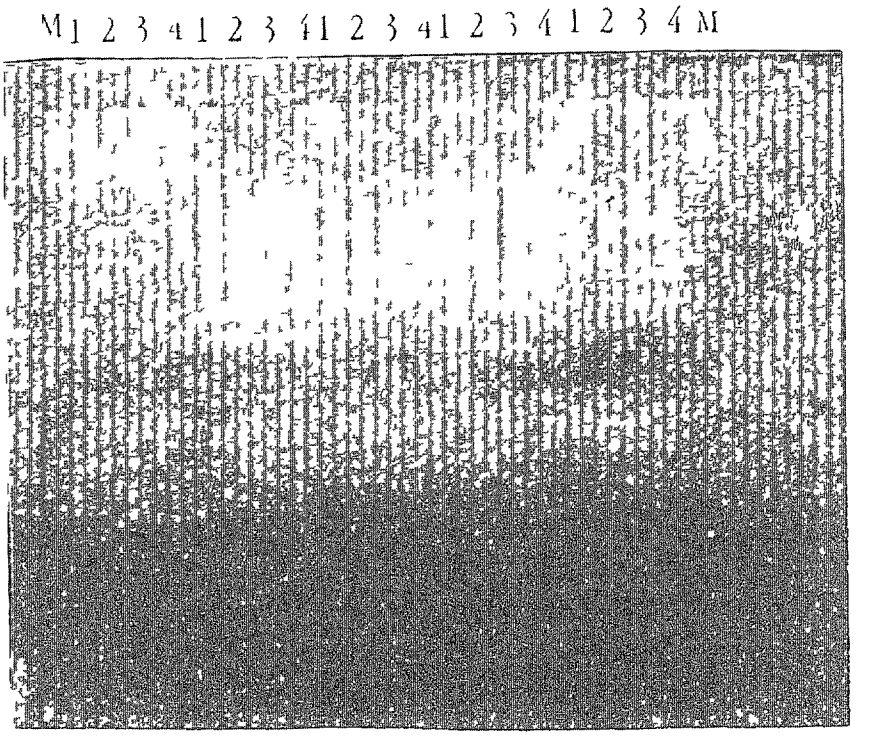
1 IR58025A	4 IR27723(R)	7 IR10198(R)
2 IR58025B	5 IR9761 (R)	8 IR62829A
3 IR40750(R)	6 IR34686(R)	9 IR62829B

Fig 8 RAPD fingerprint of male sterile and restorer lines

Mapping genes for Quantitative Trait Loci (QTLs) contributing to yield

Studies were initiated to assess the level of polymorphism among parental lines with the objective to identify the QTLs contributing to yield with the help of DNA markers Initial screening of the parental material used for generating a mapping population for identifying genes contributing to yield was considered as a prerequisite Using RAPD technique four parental lines (IR64, Vikas (I), 9314 (J) and Pusa 743 1-1) to be used in making crosses were screened using 10 random decamer primers Sufficient level of polymorphism was observed with majority of the primers (Fig 9)

Based on this information parents were hybridised to generate requisite populations recombinant inbred lines (RILs) or advanced intercrossing lines (AILs)



With OPB 9 OPB 10 OPB-11 OPB 12 and OPB-13 primers

1 IR64

2 Pusa 743-1 1

3 9314(japonica)

4 Vikas

Fig 9 RAPD fingerprint of rice genomic DNA of parental material

PHYSIOLOGY

LEAD RESEARCH

Response of hybrids and varieties to different dates of sowing and planting

A field experiment was conducted to compare responses of hybrids and varieties in phenology growth and productivity to different sowing dates during the dry season of 1996 under irrigated condition The crop (10 hybrids and 2 varieties) was sown on 22 Dec 95, 1 Jan 96 and 12 Jan 96 and transplanted on 1, 8 and 15th Feb 96 respectively The average air temperature and relative humidity during crop growth did not differ much between the planting dates However total sunshine hours from planting till flowering of the crop planted on 15 Feb 96 was lower than those for the two crops planted earlier by a week and a fortnight

Hybrids seemed to be more stable in phenological development under d fferent planting dates as the earliness in flowering and maturity was relatively less than that in varieties in the later (second and third) plantings (Table 23)

Hybrids had larger leaf area index at flowering and greater shoot dry matter at flowering and at maturity and produced more grain yields than varieties in all the three plantings (Table 24) Planting dates caused quantitative variation in some components of growth and productivity of the hybrids and varieties Dry matter accumulation in stem + sheath at flowering increased progressively from first to third planting in hybrids Leaf dry matter panicle dry matter and shoot dry matter at maturity grain number per m2 and grain yield of varieties were higher in second planting, unlike in hybrids

Grain number per panicle seemed to be more sensitive to planting dates in hybrids than in varieties although grain to spikelet number percentage was similar in both hybrids and varieties in the three planting dates (Table 25)

The results show that although phenological development was more stable in hybrids when planting dates varied the decrease in grain number per panicle under later plantings was more in hybrids than in varieties This suggests that the optimum date of sowing and planting for hybrids in earlier to that of varieties in the dry season

Table 23 Phenology of hybrids (10) and varieties (2) under different dates of sowing in 1996 DS

Phenology	Genotypes	Sowing I	Sowing II	Sowing III
Days to initial flowering	Hybrids	118	114	109
	Varieties	119	112	104
	mean	118+0 5	114+0 6	108+0 5
Days to 50% flowering	Hybrids	123	120	114
	Varieties	123	118	110
	mean	123+0 6	119+0 6	113+0 5
Days to maturity	Hybrids	154	149	145
	Varieties	151	148	139
	mean	153±0 5	149+0 6	144+1 8

Table 24 Phenology of hybrids (10) and varieties (2) under different dates of sowing in 1996 DS

Phenology	Genotypes	Sowing I	Sowing II	Sowing III
1 Tiller no /m2 at flowering	Hybrids		546	525
	Varieties	580542	497	104
	mean	573±90 2	538±31 5	523±35 7
2 LAI at flowering	Hybrids	4 8	4 2	3 8
	Varieties	4 1	3 3	3 1
	mean	4 7±0 20	4 1±0 19	3 7±0 14
3 Dry matter(g/m2) at flowering	Hybrids	312	270	273
	Varieties	273	287	269
i Leaves	mean	305±21 1	273±15 0	272±22 5
ii Stem + Sheath	Hybrids	731	762	793
	Varieties	654	709	766
	mean	718±48 3	753±35 8	788±53 5
iii Panicle	Hybrids	184	185	180
	Varieties	163	155	154
	mean	181±17 0	180±183	176±17 0
iv Total	Hybrids	1221	1217	1246
	Varieties	1090	1152	1190
	mean	1199±67 7	1206±58 7	1236±79 1
4 Day matter(g/m2) at maturity	Hybrids	310	293	271
	Varieties	240	289	210
i Leaves	mean	298±28 7	293±16 8	260±23 3
ii Stem + Sheath	Hybrids	503	503	497
	Varieties	429	470	415
	mean	491±38 2	498±7 6	482±29 1
iii Panicle	Hybrids	1002	916	885
	Varieties	708	736	668
	mean	953±40 0	886±40 0	45 0
iv Total	Hybrids	1817	1714	1651
	Varieties	1378	1495	1292
	mean	1744±81 4	1678±58 5	1591±79 4

Table 25, Yield and its components of hybrids (10) and varieties (2) under different dates of sowing in 1996 DS

Growth Parameters	Genotypes	Sowing I	Sowing II	Sowing III
1 Grain yield (g/m^2)	Hybrids	841	778	744
	Varieties	590	616	560
	mean	799±35 5	751±36 7	713±39 8
2 Panicle no /m^2	Hybrids	458	456	461
	Varieties	399	436	407
	mean	499±16 9	453±18 8	452±25 0
3 Grain no /m2 (x 1000)	Hybrids	47 2	43 7	42 2
	Varieties	26 6	30 7	27 9
	mean	44 3±2 1	41 5±21 1	39 9±2 4
4 Grain no /panicle	Hybrids	103	95	92
	Varieties	74	71	70
	mean	98±5 1	92±4 4	88±6 6
5 Filled grain no (%) flowering	Hybrids	61	62	61
	Varieties	62	66	63
	mean	61±4 4	63±4 4	62±4 3
6 1000 grain wt (g)	Hybrids	18 2	18 3	18 1
	Varieties	20 4	20 2	19 9
	mean	18 5±0 3	18 6± 0 19	18 4±0 25
7 Harvest index(x)	Hybrids	47	45	45
	Varieties	43	41	43
	mean	46±1 7	45±1 6	45±1 7

Effect of panicle density at flowering on filled grain percentage in hybrids

A field experiment was conducted with 8 hybrids and 2 varieties in the wet season of 1996 with the objective of finding out the effect of reduction in panicle density on filled grain percentage

Reduction in panicle density to 70% of the control during grain filling phase did not improve filled grain percentage However when the panicle density was less than 40% of the control, an increase of 8 to 10% in filled grain percentage was observed Since 1000 grain wt was similar in all the three treatments it cannot be inferred that the filled grain percentage was limited by assimilate upply for grain filling Dry matter production was greater per unit LAI or for every thousand spikelets in the treatments in which panicle density was reduced at flowering But it did not lead to enhancement of filled grain percentage if the crop had 70% of the number of panicles as in control It suggests that assimilate availability and filled grain percentage may not be directly related under condition of normal spikelet number

Co-ordinated research

Six experiments were conducted at 12 participating locations to understand crop responses to abiotic conditions of rainfed rice spatial influence on phenology of parental lines of rice hybrids, and genotype and environment interaction on growth and yield of irrigated rice

Modern genotypes IET 13170 and Tulasi could withstand moisture stress due to mild drought condition at grain filling phase more than traditional ones like N22 at Kanpur and Dehula at Rewa IET 13170 and Tulasi had higher crop and panicle growth rates and greater stem reserves during grain filling

Water logging under intermediate to semi deep conditions decreased the yield of Sabita and Utkala Prabha by reducing dry matter content of shoot and panicle number per unit area This effect could be overcome by increasing the plant density through closer planting under direct seeding

Days to flowering in A and R parental lines of rice at different locations was not related to variation in the latitude The study on genotype x environment interaction on phenology, growth and yield of irrigated rice at Hyderabad and Maruteru, revealed that variation in days to flowering and grain yields were more pronounced in early duration cultivars than late cultivars The filled grain percentage, grain yields and harvest index were lower at Maruteru probably due to relatively shorter grain filling duration

CROP MANAGEMENT

AGRONOMY

Co ordinated research

Co ordinated multi location testing programme has been designed to address the critical issues to sustain the yield maximization resource base management, enhance P use efficiency evaluating herbicides for rice under different ecosystems and optimize agronomic package of practices for hybrid rice and scented varieties and intercropping of rice with ID crops

Yield maximization trials conducted at 12 locations indicated the existing recom mended fertilizer dose in conjunction with micro-nutrients or changing local recommended NPK dose to the balanced ratio of 4 2 1 (NPK) with or without FYM produced the maximum grain yield However in some parts of the country different ratios of NPK have been worked well for instance 3 1 2 at Titabar and 4 2 5 1 at Sabour produced the highest grain yield

A suitable package for direct seeding situation has been developed based on the data from 12 locations the package involve sowing sprouted seed in lines, using herbicide (butachlor) at 4-6 days after sowing (DAS) followed by one spot weeding at maximum tillering stage Recommended dose of NPK was applied 1/3rd N, full P2O5, and 75% K20 as basal dressing, 1/3rd N at tillering and remaining 1/3rd N at 25% K20 at PI is the best agronomic package for obtaining higher grain yields

Appropriate P sources and methods of P application techniques were evaluated at eight locations to optimize P nutrient use and to identify the P efficient varieties Varieties like TNAU 91002, Jyothi, Prabhat Abhaya, IR-26 were found to be the most efficient in terms of P use efficiency as compared to the Rasi at Coimbatore Patambi, Pusa Patna Titabar Aduthurai and Chinsurah locations, respectively Interesting observations were also made on source and method of P application showed positive response in North eastern states compared to Southern states Higher analysis P fertilizer like DAP @ 40 kg P_2O_5/ha was most effective only at Arundhutinagar when applied to soil as basal dressing

Among the herbicides Anilophos 18EC (Rico), Ethoxysulfuron + Anilophos and Butachlor + 2,4 D Na and Argold were the most effective in transplanted rice ecology Butachlor + safener or ethoxysulfuron + anilophos were most effective in controlling weed flora in direct sown rice under puddled ecology Similarly herbicide combinations involving 2,4 D Na (Pendimethalin fb 2 4 D Na butachlor and anilophos fb 2 4 DNa) provided effective weed control in rainfed direct sown rice

Important items among the package of practices for hybrid rice include seed density @ 10 20 gms/m sq nursery and use of 2 seedlings/hill With the hybrids evaluated N response was significant only up to 150 kg/ha N applied 50% basal + 25% tillering + 25% at booting stage as PU gave the best yield advantage Cyclic submergence for hybrids was found on par with continuous submergence as reflected in grain yield at DRR

Application of N levels influence the grain yield of basmati varieties up to 90 kg N/ha only Also N levels did not exhibit any appreciable influence on quality parameters of scented varieties First fortnight of July planting (early planting) of scented varieties at Pantnagar Karjat DRR Wangbal, Kalyani and Chiplima and second fortnight of July plantings at Varanasi and Sabour recorded the maximum grain yield

In rainfed uplands of Tuljapur and Kanpur rice + Pigeonpea are profitable with varieties Terna + BDN-2 and Aswini + Manak respectively, while rice + Soybean at Jagadalpur and Almora with varieties MW 10 + PK 472 and VL Dhan 221 + VLS 2

respectively, and rice+cotton at Mugad with Amrut + DCH-32 exhibited the best performance in terms of rice equivalent yield and gross returns

Lead research

Integrated Nutrient Management on grain yield and nutrient uptake in transplanted rice

Grain yield differences between green manure (GM) and farm yard manure (FYM) applied during *Kharif* was not significant in *Rabi* 95-96 (2nd crop) The per cent yield increase due to conjunctive use of GM and FYM over control was 16 22 and 7 26 respectively Averaged over fertilizer treatments the reduction in mean grain yield was 11 per cent only when fertilizer dose was cut to half Nutrient uptake studies (*Rabi* 95-96) indicated that conjunctive use of GM or FYM with inorganic fertilizers recorded higher uptake at harvest stage of the crop compared to values obtained from application of inorganic fertilizers alone (Table 26) indicating some carry over effect of organic manures applied in *Kharif*

Evaluation and adoption of the chlorophyll meter (SPAD) and leaf color scale techniques for efficient 'N' management in irrigated rice

During *Kharif* 96 CREMNET Project experiments were conducted to evaluate and adoption of the chlorophyll meter and leaf colour scale techniques for efficient N management in lowland rice ecosystems at DRR Rajendranagar Total of 9 varieties viz , 3 high yielding varieties 3 hybrid and 3 scented rice varieties were evaluated under different N levels along with SAPD value based N' application

Averaged over varieties N application based on SAPD (502) values gave significantly maximum grain yield (4 59) followed by the highest N dose of 135 kg/ha {(3 splits B + T + PI (N% at each stage)} Among the cultivars hybrids gave higher yields than HYV and basmati varieties Averaged over N application ProAgro recorded significantly maximum grain yield of 4 79 t/ha Nitrogen x variety interaction effects were significant (Table 27)

Table 26 Effect of organic manures on grain yield (t/ha)

Treatments	Higher dose of NPK (120 80 40)		Lower dose of NPK (60 40 20)	
	Rabi 95 96	*Kharif* 96	*Rabi* 95 96	*Kharif* 96
G M + NPK	5 18	5 02	4 42	4 46
FYM + NPK	4 63	4 84	4 22	4 42
NPK alone	4 22	4 06	4 03	3 77
Mean	4 68	4 64	4 22	4 21

Table 27 Effect of Nitrogen on grain yield of rice varieties *Kharif* 1996

	Cultivars	Grain yield t/ha	N management (N kg/ha)	Grain yield t/ha
HYVs	Rasi	4 26	N-0	3 08
	Vikas	4 32	N 45	3 96
	Krishna Hamsa	4 25	N 90	4 15
	Mean	4 28	N-B5	4 51
Hybrids	Proagro-6201	4 79	N SPAD based*	4 59
	DRRH 1	4 20	Mean	4 06
	VRH-4	4 39		
	Mean	4 46		
Scented	Kasturi	3 26		
	Pusa Basmati	3 28		
	IET 13549	3 77		
	Mean	4 06		

*Applied 'N when SPAD values fall below 35

C D (0 05) Nitrogen treatment - 0 19, Variety 0 08 Interaction MxS 0 43 SxM 0 42

Quality parameters

The quality parameters of 9 cultivars viz , HYV scented and hybrid varieties are presented in (Table 28) It is clear from the results that Vikas recorded the highest brown rice recovery (80 7%) as compared to all other entries tested Among scented varieties Kasturi recorded maximum brown rice recovery (78 1%) while there was not much difference among hybrids The per cent of husk was maximum with IET 13549 (26 0%) followed by Pusa Basmati (25 0%) ProAgro 6201 recorded maximum milled rice followed by Kasturi and DRRH-1 The rice bran recovery was highest with ProAgro(8 5%) when compared to rest of the cultivars Krishna hamsa and Kasturi recorded the least bran values

Among HYVs the maximum head rice recovery of 64 5% was recorded with Krishna Hamsa followed by Kasturi and Vikas and the least value was registered with Rasi DRRH 1 recorded the best head rice recovery value among hybrids

Among HYVs Krishna hamsa recorded the least test weight 21 2 (g) comparable with Kasturi and Pusa basmati DRRH 1 among hybrids and Pusa basmati among scented varieties recorded lowest test weight of 22-6 and 21 5 respectively over other cultivars

Table 28 Quality parameters of the HYVs, Scented and Hybrids, *Kharif* 1996

Cultivar	Brown Rice (%)	Husk (%)	Milled Rice (%)	Bran (%)	Head Rice (%)	Broken Rice (%)	TW (g)
HYV							
1) Rasi	78	22	70 5	7 7	48 6	12 7	22 5
2) Vikas	80 7	19 3	73 1	7 6	63 0	6 7	24 4
3) Krishna Hamsa	78 1	21 9	71 1	7 0	64 5	6 0	21 9
Scented							
4) IET 13549	74 1	26 0	66 7	7 1	54 3	11 1	22 3
5) Pusa basmati	74 9	25 0	67 3	7 6	54 6	9 6	21 5
6) Kasturi	78 1	21 9	71 1	7 0	64 5	6 0	21 9
Hybrids							
7) ProAgro	77 0	23 0	68 5	8 5	53 0	12 4	23 3
8) VRH-4	78 3	21 7	70 4	7 9	60 0	8 0	24 2
9) DRR-1	78 6	21 4	71 3	7 4	61 6	7 4	22 6

On-farm evaluation of direct wet seeding at Nizamabad

During *Kharif* 1996 three methods of crop establishment i e broadcasting of sprouted seeds, Row seeding of sprouted seeds and transplanting were tested with Phalguna variety at Krishi Darshan Kendra Nizamabad The grain yield differences were significant under different stand establishment methods The maximum grain yield (4 35 t/ha) was recorded under row seeding of sprouted seeds followed by transplanting (4 10 t/ha) and both these methods were significantly superior over broadcasting of sprouted seeds (2 97 t/ha) The grain yield differences between row seeder and transplanting were non-significant (Table 29)

Table 29 Grain yield as influenced by different methods of crop establishment

Method	Grain yield (t/ha)
Broadcast	2 97
Drum seeder	4 35
Transplanting (Farmers practice)	4 10
C D 0 05%	0 58

Influence of sulphur on yield of varieties and hybrids

In recent years sulphur deficiency is occurring commonly in continuously submerged and continuously rice cropped areas and increased use of high analysis non-sulphur containing fertilizers During *Kharif* 1996, n order to find out the response of six varieties viz Rasi Ajaya and Jaya, Hybrids viz DRRH1 KMRH1 and ProAgro 103 were tested with two levels of sulphur fertilization (20 kg/ha and 40 kg/ha) Recommended NPK (as S free fertilizer) and cultural practices followed were uniform for all the treatments Sulphur application @ 40 kg/ha showed the highest grain yield in all varieties and hybrids tested Among the varieties tested Ajaya recorded the highest grain yield of 3 63 t/ha followed by Jaya with 3 59 t/ha Rasi recorded significantly lower grain yield (3 22 t/ha) among all the test Among hybrids KHRH 1 with 4 39 t/ha was observed to be the highest yielder followed by ProAgro 103 with 4 08 t/ha Both these hybrids were significantly high yielders when compared wit DRRH1(3 53 t/ha) Interaction between varieties/hybrids and sulphur levels were significant showing that at 20 kg sulphur application hybrids produced better yields

compared to varieties and KMRH-1 recorded higher yield at 20 kg/ha as compared to 40 kg/ha sulphur application Remaining varieties and hybrids recorded significantly higher yields at 40 kg Sulphur/ha (Table 30)

Interaction studies between Nursery seed rates and depths of planting in rice

A field experiment was conducted during 1996 *Kharif* season to assess the effect of different seed rates used in nursery and depths of planting in main field on growth and grain yield of rice varieties Two varieties Ajaya and Rasi in main plots two depths of planting shallow and deep in sub-plots and three different seed rates recommended (50 kg/ha) double the recommended (100 kg/ha) and half the recommended 25 kg /ha were taken in sub-sub plots in split-split plot design Recommended fertilizer dose with N in three split applications and remaining fertilizers as basal application irrigation and other cultural practices were uniform for all the treatments Biometric observations and yield were recorded in the plot at important stages Results showed that between the two depths of planting irrespective of variety used (Rasi and Ajaya) shallow planting (2 cm depth) recorded significantly higher yield Maximum plant height was recorded with half the recommended seed rate i e 25 kg/ha Chlorophyll meter readings were different for two varieties and coincided with leaf colour scale with marginal difference in grain yield It is worth noticing that reduced seed rate with shallow planting of medium duration high yielding variety produced good yields equal to that of recommended or double the recommended seed rates (Table 31)

Table 30 Influence of Sulphur application on yield of varieties and hybrids

Treatments		Grain yield (t/ha)		
		20 kg/ha	40 kg/ha	Mean
Varieties				
Rasi	M1	2 99	3 46	3 23
Ajaya	M2	3 48	3 78	3 63
Jaya	M3	3 50	3 69	3 60
DRRH-1	M4	3 30	3 73	3 52
KMRH-1	M5	4 58	4 20	4 39
ProAgro 103	M6	3 96	4 20	4 08
	Mean	3 64	3 84	—
	C D (5%)			
	Main in Sub	0 46		
	Sub in Main	0 32		
	Main plots	NS		

Table 31 Effect of seed rates in nursery and depth of planting on performance of two rice varieties

Treatments	Plant height at MT stage (cm)	SPAD Values at MT stage	Grain yield (t/ha)
Main plots			
Ajaya	55 58	37 27	4 32
Rasi	56 95	34 22	4 28
C D (5%)	NS	2 93	NS
Sub-plots			
Shallow planting (<3cm)	60 23	35 78	4 66
Deep planting (>5 cm)	52 29	35 72	3 94
C D (5%)	2 41	NS	0 20
Sub plots			
Recommended seed rate	56 88	37 49	4 25
Double the rec seed rate	51 97	34 54	4 42
Half the rec seed rate	59 95	35 21	4 23
C D (5%)	2 01	1 94	NS

Influence of date of planting and N levels on grain yield and quality of scented rice varieties

Pusa Basmati-1 IET 13548 and Taraori basmati were transplanted under 15th July and 25th July with 4 levels of nitrogen (0 30 60 and 90 kg N/ha) 10th July planting date recorded significantly higher grain yield (3 00 t/ha) than 25th July planting date (2 54 t/ha) Maximum grain yield of 3 10 t/ha was recorded by IET 13548 followed by Pusa Basmati-1 (3 08 t/ha) and both these varieties were significantly superior over Taraori basmati (2 12 t/ha) Applied nitrogen increased grain yield significantly up to 90 kg N/ha (3 31 t/ha) (Table 32)

Table 32 Effect of date of planting and N levels on grain yield of basmati varieties

Treatments	Grain yield (t/ha)
Varieties	
Pusa basmati 1	3 08
IET 13548	3 10
Taraori basmati	2 12
C D (5%)	0 09
Date of planting	
15th July	3 00
25th July	2 54
C D (5%)	0 19
N-levels (kg N/ha)	
0	2 12
30	2 56
60	3 09
90	3 31
C D (5%)	0 11

Grain quality parameter analysis shows that among varieties Pusa basmati-1 recorded maximum values of Head Rice Recovery (59 0%) Kernal length (7 36 mm) Kernel breadth (1 88 mm) L/B (4 04) Kernel length after cooking (15 1 mm) Amylose (24 3%) Volume Expansion Ratio (4 45) and Water Uptake (357 ml) while IET 13548 recorded maximum values of elongation ratio (2 14) Planting date of 25th July recorded maximum values of Head Rice Recovery (58 9%) volume expansion (4 47) while maximum value of Kernal length after cooking (14 9 mm), elongation ratio (2 09) and Amylose content (22 49%) and water uptake (219 ml) were recorded by 15th July planting Applied nitrogen did not showed consistent results on grain quality parameters (Table 33)

Effect of irrigation schedules and N levels on grain yield and quality of scented rice varieties

During *Kharif* 1996, two dwarf scented rice varieties(Pusa basmati-1 and IET 13548) and one local traditional tall variety (Taraori basmati) were tested under two irrigation schedules (continuous submergence (5+2 cm) and cyclic submergence with four levels of nitrogen viz 0 30 60 and 90 kg N/ha (Table 34) Grain yield differences between continuous submergence and cyclic submergence were non significant however, about 1 q/ha extra grain yield was recorded under cyclic submergence Variety IET 13548 recorded maximum grain yield (3 75 t/ha) followed by Pusa basmati 1(3 69 t/ha) but both these varieties were significantly superior over Taraori basamti (2 51 t/ha) Among different applied N levels grain yield increased significantly up to 90 kg N/ha (3 99 t/ha)

Table 33 Quality parameters of scented rice varieties under different dates of planting and N levels

Treatments	M (%)	HRR (%)	KL (MM)	KB (MM)	L/B	Alkali value	VER	KLAC (mm)	ER	Amylose (%)	WU (ml)
Date of planting											
15th July	64 3	58 1	7 19	1 77	4 03	4 7 4 7	4 15	14 9	2 09	22 49	219
25th July	64 3	58 9	7 15	1 78	4 02	4 9 4 9	4 47	14 7	2 08	21 96	193
Varieties											
Pusa basmati 1	63 5	59 0	7 36	1 88	4 04	7 0 7 0	15 1	4 50	2 05	24 30	357
IET 13548	64 9	58 3	6 94	1 73	4 03	4 2 4 2	4 27	1 7	2 14	21 38	162
Taraori basmati	63 7	58 3	7 35	1 771	4 3	3 7 3 7	4 26	14 6	2 01	22 40	144
N-levels (kg N/ha)											
0	64 0	57 6	7 14	1 75	4 09	4 9 4 8	4 22	14 6	2 08	23 03	211
30	64 2	58 6	7 21	1 77	4 08	4 8 4 9	4 23	14 9	2 06	23 09	214
60	64 3	59 2	7 13	1 79	4 07	4 6 4 7	4 33	15 0	2 10	21 70	210
90	64 7	58 4	7 11	1 74	4 09	5 1 4 9	4 55	14 8	2 08	21 64	190

Table 34 Effect of irrigation schedules and N levels on grain yield of basmati varieties

Irrigation Schedule	Grain yield (t/ha)
Water management schedules	
1 Continuous submergence (5±2)	3 27
2 Cyclic submergence	3 38
C D (5%)	NS
Varieties	
Pusa basmati 1	3 69
IET 13548	3 75
Taraori basmati	2 51
C D (5%)	0 14
N levels (kg N/ha)	
0	2 46
30	3 19
60	3 64
90	3 99
C D (5%)	0 28

Table 35 Influence of N rates and their time of application on grain yield of hybrid rices

Treatments	Grain Yield (t/ha)
Varieties	
Vikas	4 05
KHR 1	4 94
ProAgo 103	5 23
MGR 1	4 76
Rasi	4 57
C D (5%)	0 25
N rates (kg N/ha)	
0	3 45
60	4 77
120	5 39
180	5 23
C D (5%)	0 25
N schedules	
S1	4 76
S2	4 78
S3	4 60
C D (5%)	NS

Varietal response to N rates and their schedules on grain yield of selected hybrids During *Rabi* 95 96 graded levels of nitrogen (0, 60 120 and 180 kg N/ha) and 3 schedules of N application i e 3 splits (50% basal + 25% tillering + 25% panicle initiation) 4 splits (25% basal + 25% tillering, + 25% panicle initiation and 25% booting stage) and 5 splits (25% basal + 25% tillering + 25% panicle initiation and 25% in two equal splits i e , at 50% flowering and at 10 days after of 50% flowering) were tested with 3 hybrids (KHR 1 ProAgro 103 and MGR-1) along with Vikas and Rasi as standard check ProAgro 103 recorded maximum grain yield (5 23 t/ha) followed by KHR-1 (4 94 t/ha) but ProAgro-103 was significantly superior over Vikas (4 05 t/ha) MGR-1 (4 76 t/ha) and Rasi (4 57 t/ha) Graded levels of Nitrogen increased grain yield significantly up to 120 kg N/ha (5 39 t/ha) Different schedules of N application did not influence grain yield significantly (Table 35)

Influence of different N schedules on grain yield of rice varieties under direct seeded puddled conditions During *Kharif* 1996 three rice varieties, IET 9994, Ajaya and Shalivahana were tested under 7 schedules of N applications i e 1/2 at basal + 1/4th at tillering + 1/4th Panicle initiation (T1), 1/3rd at basal + 1/3rd at tillering + 1/3rd at panicle initiation (T2) 1/3rd at 21 days after sowing (DAS) + 1/3rd at 42 DAS + 1/3rd at 56 DAS (T3) 1/4th at 21 DAS + 1/4th 42 DAS + 1/2 at 56 DAS (T4) 1/2 at 21 DAS + 1/4th at 42 DAS + 1/4th at 56 DAS (T5) 1/3rd at 21 DAS + 1/3rd 35 DAS + 1/3rd at 45 DAS (T6), and 1/2 at 21 DAS + 1/2 at panicle initiation(T7) Among the varieties, maximum grain yield of 6 13 t/ha was recorded by Ajaya followed by Shalivahana (5 69 t/ha) and IET 9994 (5 49 t/ha) However IET-9994 recorded significantly lowest grain yield than Ajaya Maximum grain yield 6 20 t/ha was recorded by treatment (T5) followed by T7 (6 07 t/ha), T4 (6 06 t/ha) T6 (5 76 t/ha) T3 (5 74 t/ha) and T1 (5 70 t/ha) but all these treatments were at par with each other Significantly lowest grain yield of 4 89 t/ha was recorded under T2 (Table 36)

Table 36 Influence of varieties and N scheduling on grain yield of direct seeded puddled conditions

Treatment		Grain yield
	Varieties	
IET 9994		5 49
Ajaya		6 13
Shalivahana		5 69
C D (5%)		0 46
	N schedules	
T1	1/2 at B + 1/4th at T + 1/4th at PI	5 70
T2	1/3rd at B + 1/3rd at T + 1/3rd at PI	4 89
T3	1/3rd at 21 DAS + 1/3rd at 42 DAS + 1/3rd at 56 DAS	5 74
T4	1/4th at 21 DAS + 1/4th at 42 DAS + 1/2 at 56 DAS	6 06
T5	1/2 at 21 DAS + 1/4th at 42 DAS + 1/4th at 56 DAS	6 20
T6	1/3rd at 21 DAS + 1/3rd at 35 DAS + 1/3rd at 45 DAS	5 76
T7	1/2 at 21 DAS + 1/2 at PI	6 07
	C D (5%)	0 65

B = Basal, T = Tillering, PI = Panicle Initiation DAS = Days After Sowing,

Screening rice varieties under different phosphorus levels

During *Kharif* 1996 sixteen cultures along with released varieties were tested under 6 levels of phosphorus (0 10 20 30 40 and 50 kg P_2O_5/ha) Grain yield difference among phosphorus levels were non-significant while varieties differed significantly for their grain yield Higher grain yield of 4 18 t/ha was recorded by IR 64 followed by DRRH 1 (4 17 t/ha) IET-12512 (3 79 t/ha) and IET 12510 ,(3 83 t/ha) and lowest grain yield of 2 69 t/ha was recorded by IET 12029

Screening of herbicides for weed control in transplanted rice

Transplanted condition In the experiment of testing efficacy of herbicides on weed control and grain yield of transplanted rice under irrigated conditions conducted during *Kharif* '96, some new rice herbicide formulations were tried along with promising ones Acetochlor 90 % EC @ 0 05 and 0 10 kg a i /ha Rico 18 EC @ 0 375 and 0 450 kg a i /ha Aniloguard plus 56 EC @ 0 72 kg a i ha Hoe 95404 + Anilophos 15 WDG + 30 EC @ 0 015 + 0 30 kg a i /ha and Oxadiargyl 80 WP @ 0 15 kg a i /ha were tried along with two hand weedlings at 20 and 40 days after transplanting and unweeded check with Rasi variety Due to heavy rain at the time of harvesting yields were low in all the treatments Rico at both concentrations recorded significantly higher yields of 3 13 ad 3 10 t/ha followed by Aniloguard plus (3 00 t/ ha) which were comparable with two hand weedings treatment Acetochlor was toxic at both the concentrations and especially at higher concentration to the rice crop and hence very low yield of 0 42 t/ha was recorded and on par with unweeded check Oxadiargyl recorded significantly low yields when compared to Rico and Aniloguard plus From this experiment it was found that Rico and Aniloguard are equally effective in transplanted rice

Direct sown rice under puddled conditions

The experiment on screening of herbicides for weed control in direct sown rice under puddled conditions initiated during 1995 was continued during *Kharif* 1996 The treatments comprise pretilachlor + safener 30 EC @ 0 6 kg a i /ha butachlor + safener 50 EC @ 1 5 kg a i /ha Hoe 95404 (15 WDG) + Anilophos (30 EC) @ 0 015 + 0 3 kg a i /ha Aniloguard plus 56 EC @ 0 7 and 0 93 kg a i / ha, Whipsuper 9 EC @ 0 06 kg a i /ha Argold 10 EC @ 0 05 and 0 075 kg a i /ha along with weed free check and two hand weedings Argold was applied a week after sowing whipsuper was applied 15 days after sowing while Aniloguard Hoe 95404 + Anilophos at 10 days after sowing Remaining herbicides were applied 3 days after sowing Weed free check recorded highest grain yield of 3 6 t/ha Butachlor + safener recorded a grain yield of 3 4 t/ha which was on par with weed free check Argold (lower dose) recorded lowest grain yield of 1 5 t/ha which was significantly poor when compared to Argold (higher dose) and other herbicides

Fig 10 a Nursery growing for rice transplanter

Conservation tillage

Conservation tillage with herbicide application i e two ploughings followed by herbicide application to weeds followed by planting showed considerable yield performance Herbicide Round up @ 750 ml/acre applied with conservation tillage recorded good yield of 3 48 t/ha as against higher doses

AGRICULTURAL ENGINEERING

Evaluation of direct seeders and transplanters for rice crop establishment

Direct seeding of pregerminated paddy with row seeder eliminated the operations like nursery raising and transplanting, saves labour and time facilitates line sowing to take up mechanical intercultural operations While the transplanter and manual transplanting needed 214 and 347 man hr/ha respectively the row seeder required only 8 man hrs to cover one hectare With row seeder there is a net saving (in cost of operation) of Rs 649/ha and 1080/ ha as compared to that of transplanter and manual transplanting respectively The yield levels of Row Seeder is more as compared to manual transplanting

Fig 10 b Mechanical Transplanter

SOIL SCIENCE

Co-ordinated Research

Soil Science Co ordinated trials were designed by and large to generate sustainable soil fertility and key nutrient management technologies for rice and rice based cropping system across disparate soil andenvironmental locations Salient findings include noticeable increase in build up of soil organic matter on account of combined use of organic (FYM, GM) and inorganic fertiliser sources over time in the long term study on soil fertility Dual use grain cum green manuring green gram was found superior as pre rice crop at Faizabad and Kanpur in the trial on combined use organic manures with inorganic fertiliser (Urea) Linear responses to applied Zn up to 20 kg/ha was observed in alkaline soil at Faizabad while at Mandya the response was curvilinear with maximum yield at 10 kg Zn/ha Maximum P response in irrigated soils was restricted to moderate dose of 20 kg P_2O_5/ha while in uplands the response to applied P was understandbye at higher dose of 30 kg P_2O_5/ha Rice genotypes were found to vary in their N use efficiencies Swarna was found to fare well across locations both under N depriving and N abundant condition thus combining in it both N use efficiency and N responsiveness In contrast, Vijeta was found to be highly N responsive variety, lacking N use efficiency trait at zero applied N

Lead Research

Soil Science lead research encompassed the realms of basic and applied aspects pertaining to soil sustainability and productivity involving essentially integrated nutrient management approaches

Use of pre-kharif sole/dual legume green manures and rice based cropping systems

Soil Productivity Dual/Sole green manure legumes and green manure crops in pre rice (May July) season contribute N to succeeding rice crop by BNF as well as by accumulating loss prone soil NO3 N formed in summer Further inclusion of soil building legume crops in rotation with rice in *rabi* contribute to soil sustainability and stabilise soil productivity During 1996 *Kharif* dual use green gram yielded grain on the average 4 99 t/ha besides leaving behind 23 8t/ha crop residues for incorporation Sunnhemp and daincha obviously contributed relatively higher biomass of about 50 t/ha each The succeeding *Kharif* rice receiving green manures gave higher grain yield over fallow (3 47 t/ha) Correspondingly N uptake was also higher in green manure received plots over Fallow (Table 37)

Table 37 Influence of pre *Kharif* green manure on rice yield & N uptake

Treatment	Grain rice yield (t/ha)	Total N uptake (kg/ha) by rice
Fallow	3 47	88 6
Cowpea	3 73	95 4
Green gram	3 76	97 5
Sunnhemp	3 74	105 3
Dhaincha	3 81	111 9
CD (0 05%)	0 124	10 4

Among the non rice crops following *Kharif* rice, groundnut which requires friable tilth for sending its gynophores into soil for successful development into pods was seen to benefited by dhaincha which contributed more soil organic matter Sesamum which also requires favourable soil tilth was observed to yield better in green manured plots as compared to fallow Sunflower was not influenced by residual effects of *pre kharif* green manures (Table 38)

Rotation of upland rice with bengal gram

Rotation of upland rice with bengalgram in black soils resulted in doubling of *Kharif* upland rice grain yields Rainfed rice following *rabi* fallow plots gave on the average 775 kg/ha as against 1543 kg/ha recorded in bengalgram grown plots The observed higher rice yield in bengal gram rotated plots were ascribed to increased availability of N by BNF and P by solubilisation effects of acidic root exudates of preceding bengalgram Further response of upland rice to applied P was recorded up to 40 kg P2O5/ha by observed increase in grain yield from 1543 kg/ha at 20 kg P2O5/ha to 2226 kg/ha in plots that received 40 kg P2O5/ha The extent of relative increase in soil available P was more (157 7) observed in deeper soil layer (2550 cm) where bengalgram root activity is expected to be maximum as compared to surface layer (0-25 cm) where increase was relatively less (76 3%) (Table 39)

Table 38 Residual effect of *pre- kharif* green manures on non-rice *rabi* crops

Pre-kharif Treatment	*Rabi* crop grain yield (Q/ha)		
	Groundnut	Sesamum	Sunflower
Fallow	11 54	3 14	7 14
Cowpea	12 70	4 02	10 70
Greengram	13 65	4 16	9 02
Sunhemp	13 30	4 05	8 48
Dhaincha	15 10	4 43	8 27
Expt mean	13 25	3 96	8 73
CD (0 05)	1 28	0 54	NS
CV (%)	5 10	7 5	16 2

Table 39 Influence of Bengal gram on rice yields and available N and P status in Soil

Treatment	Grain yield (Kg/ha)	Total N uptake (kg/ha)	Available N(Kg/ha)	Total P uptake (kg/ha)	Extent of increase availableP(%)	
Rabi - *Kharif*					Soil dpth (cm)	
1 Fallow rice (N_0P_0)	775	24 2	163	2 94	0-25	25-50
2 Bengal gram - rice (N_0P_0)	1543	46 2	192	5 01	76 3	1577
3 Bengal gram rice (N_0 P @ 40 kg/ha)	2226	62 5	202	9 00		
CD	178	5 9	5 1			

Gypsum amendment for rice-groundnut system

The observed low yield of *rabi* groundnut in rice groundnut system is more traceable to the existence of adverse soil structural indices such as crusting and higher bulk density resulting from puddling given to *kharif* rice Gypsum applied at higher dose initially would serve as an amendment to mitigate the bad effects of puddling The results so far recorded have indicated only marginal effects in first year But noticeable higher yields of groundnut (1945 kg/ha) were observed over check (970 kg/ha) when gypsum was applied at 1 5 t/ha initially suggesting structural improvement of soil which takes place over time may be responsible for observed higher yields in second year

Response of rice hybrids to potassium

Potassium is known to play a vital role in translocation of photosynthates from source to sink K requirement of hybrid rices is thus expected to be more in view of their higher sink Hence there is a need to generate research information on the dosage and timing of K for rice hybrids vis-‡-vis conventional varieties The results of the study on K nutrition in the second year showed that rice hybrids respond to K application not in the first season but in second season when soil available K has reached a critical value The magnitude of response to K in case of hybrid (19 8 kg grain/kg K2O applied) was far more than conventional high yielding varieties (5 9 kg grain / kg K2O applied)

Complementary use of organic and inorganic fertiliser sources for optimal N release

Improved synchronisation between N supply from the applied source and demand by the growing rice crop is central to improving the efficiency of N use in irrigated rice ecosystems In minerlisation study involving urea green manures and rice straw combined use of G M and urea increased N mineralisation rate by 31-56% Superimposition of rice straw incorporation was not observed to cause any adverse effects either on N minerlisation / N release rate on account of expected immobilisation on N recovery and grain yield of rice In fact this combination resulted in considerable increase of residual N for post rice crop (Table 40)

Table 40 Improving N recovery and rice yields by combined use of organic and fertiliser N sources

N Treatment	Mean N Mineralisation (Kg/N/ha)	Grain yield (t/ha)	Total N uptake (kg/ha)	NRE %	Residual N at harvest of rice crop (kg/ha)
Dhaincha	41 6	5 0	103	39 1	26 1
Dhaincha+Urea	57 6	5 7	144	40 1	31 6
Dhaincha+Urea + Straw	47 3	5 8	140	36 0	41 4
Urea	37 0	5 1	101	30 9	28 5
Control	29 3	3 2	62		15 6

Urea super granules a better N source for rice under varying water regimes

N applied for rice grown under cyclic submergence creating alternate wet and dry soil conditions is subject to high gaseous losses In the investigation aimed at finding the better N source to minimise gaseous N losses, under different water regimes, it was found under cyclic submergence where conditions exist favourable for gaseous N losses deep placement of urea super granules significantly increased N recovery (65%) uptake (128 kg N/ha) over urea (103 kg N) and GM+Urea (93 0 kg N/ha) (Table 41)

Efficient Rice Genotypes to tap native soil N

One of the key strategies for improving utilisation of soil N in rice production is to exploit genotypic differences in N uptake In the study on the amount of native soil N and its use by varieties of varying duration it was noticed that nearly 40% of native soil was confined to fairly inaccessible deeper soil layers (below 15 cm) Very early varieties like Prasanna and Aditya could recover N only from surface layers and thus respond well to applied N While late maturing Pranava and Salivahana could tap soil N from deeper layers too This differential capacities of rice genotypes to explore soil N was responsible to require 120 kg 60 kg and 0 kg fertiliser N respectively by very early, short mid duration varieties to produce similar grain yields (Table 42)

Table 41 Influence of water regimes and N sources on N uptake by rice

N sources	N uptake (kg/ha)	
	Cyclic submergence	Continuous submergence
Control	50 4	49 2
Urea in 3 splits	103 3	127 6
USG	128 1	124 2
GM+Urea	93 0	129 8

Table 42 Genotypic Variability in utilising native soil N

Variety	Grain yield (t/ha) with applied N kg/ha		
	0	60	120
Aditya	1598	2830	3992
Prasanna	1481	2213	2674
Rasi	2973	4207	4691
Sasyshree	2802	3909	4377
Pranava	4097	4961	5594
Salivahana	4305	5586	5648

Nutrient requirement for sustaining rice productivity in intensively cultivated lowland

A long term field experiment on fertility management in rice variety Rasi on a vertisol (Typic Pellustert) was initiated at DRR farm Rajendranagar in 1989-90 *rabi* season to monitor crop response to applied fertilizer nutrients The soil was initially deficient in only N, and two crops of rice were cultivated there every year using various fertilizer nutrients Response of rice to applied fertilizers through the first 11 crop seasons were given in the previous years reports The 12th and 13th crops of rice grown in 1996 were harvested and processed during the period under report The 12th crop (grown in *rabi* 1996) yielded an average 1 87 t grains/ha when no fertilizer nutrients were applied Application of recommended N fertilizer raised the grain yield to 3 70 t/ha Although fertilizer P applied over N produced no significant benefit recommended K applied over N and P increased the yield significantly (to 4 89 t/ha) Application of P and K fertilizers also caused significant increase in P and K uptake by the crop In 1996 *kharif* two varieties of rice viz Rasi and IET9240 were grown Grain yield of the crop increased significantly with application of N and P fertilizers Uptake of N, P as well as K by the crop increased significantly with application of the respective fertilizer nutrients, suggesting development of deficiency of these nutrients in the soil Although grain yield of IET9240 was significantly higher than that of Rasi total N P and Zn uptake of IET9240 were significantly lower than that of Rasi (Table 43) This result suggested that N P and K utilisation efficiency of IET9240 were higher than that of Rasi

Table 43 N, P, K and Zn uptake of two rice varieties in an intensively cropped lowland (Typic Pellustert) treated with various fertilizer nutrients Rajendranagar, *Kharif* 1996

Fertilizer nutrients treatment	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		Zn uptake (g/ha)	
	V1	V2	V1	V2	V1	V2	V1	V2
No fert control I	67	58	12 2	11 6	25 9	27 5	235	210
N	97	84	16 1	14 2	38 6	34 9	308	242
N + P	97	92	17 4	17 6	39 9	51 9	370	327
N + P + K	104	91	18 2	17 0	59 4	55 6	351	316
N + P + K + Zn	96	76	17 6	14 9	53 9	47 9	361	291
N + P + K + Zn minus S	90	95	15 6	14 5	51 1	52 5	339	309
No fert control II	69	64	10 1	8 4	29 2	36 5	228	216
No fert control III	72	64	8 9	8 2	26 8	30 1	249	200
Nutrient trt means	86	78	14 5	13 3	40 6	42 1	305	264
V means Diff	**			**		ns	**	

V1 Rasi, V2 IET9240

CROP PROTECTION

ENTOMOLOGY

HOST PLANT RESISTANCE

Brown and whitebacked planthoppers

The elite cultures and hybrids numbering 910 from different screening nurseries like National Screening Nursery 1 (NSN 1) National Screening Nursery 2 (NSN 2) Planthopper Screening Trial (PHS), Multiple Resistance Screening Trial (MRST) Initial Hybrid Rice Trial 1 (IHRT-1) and Initial Hybrid Rice Trial 2 (IHRT 2) were evaluated against BPH and a total of 54 cultures were found promising (below 3 0 score on 0 9 scale) The details of some of the promising entries are presented in (Table 44) Two of the hybrids tested were also found to be resistant About 1900 germplasm accessions were tested against BPH and 300 accessions recorded below 3 0 damage grade on 0 9 scale while 262 entries registered damage grade between 3 1 to 5 0 A total of 1025 entries from NSN 1 NSN 2 PHS MRST IHRT AHRT IRWBPHN and scented material were evaluated against WBPH From these entries 61 recorded below 3 0 damage grade while 181 entries registered damage grade between 3 1 and 5 0 Some promising entries are given in (Table 45) Of the 576 germplasm screened against WBPH 168 registered below 3 0 damage grade while 119 recorded damage grade between 3 1 and 5 0 Considering the damage grade against both BPH and WBPH 9 entries from NSN 1 32 entries from NSN 2 7 entries from PHS and 10 from MRST were found promising against both the pests recording below 5 0 damage grade Promising entries against both BPH and WBPH are shown in Table 46 and Fig 11 Germplasm accessions recording low damage grade against planthoppers are given in (Table 47)

Gall midge A total of 337 entries screened against gall midge from gall midge screening trial (GMS) gall midge special screening trial (GMSS) NSN1 MRST etc 117 cultures recorded nil damage against biotype 1 while 92 entries showed nil damage against biotype 4 From these 10 common entries recording nil damage against both biotype 1 & 4 could be identified (Table 48)

Biotypic variations in gall midge throughout the country were carried out through a trial consisting of a standard set of 10 differentials under four groups The testing was carried out at 12 locations besides green house evaluation at DRR against biotype 1 and 4 The results continued to reveal the same 5 basic patterns of reaction brought out in earlier years The reaction at DRR Raipur Sambalpur, Titabar and Warangal representing biotype 1 populations exhibited R-R R-S pattern At Cuttack the same distinct S-R R S pattern of biotype 2 reaction was continued to be observed At Jagtial the typical reaction of R S R-S representative of biotype 3 was noticed The reaction of differentials at Wangbal was similar to last year where R S-S-S pattern has emerged and the population was designated as 3M Field reaction at Ragolu and green house reaction at DRR showed the typical pattern of S-S-R S representing biotype 4 this year also At Pattambi and Moncompu field reaction of differentials followed R-R S S- pattern representing biotype 5

Fig 11 Screening of germplasm against planthoppers at Maruteru

Table 44 Promising entries against brown planthopper

IET No	Designation	Cross	Damage grade on 0 9 scale
National Screening Nursery (NSN 1)			
14436	TTB 148-4-1-1	IET 9711 / IET 11162	1 5
13944	OR 930 1 1-2	Badami / CR 143-2-2	2 1
14435	TTB 148-174 3 2 1	IET 9711 / IET 11162	2 1
14455	TTB 148-206 2 2 1	IET 9711 / IET 11162	2 1
14087	RP 1579-23071 1320	RPW 6-17 / ARC 6650	2 4
13302	OR 853 2	Daya / Sarathi	3 0
Planthopper Screening Trial (PHS)			
	KAUM 48-11 3	Thonnuran / IR 8	1 5
	RP 3422-30885	T 1432 / L 152	3 7
	MTU 10883	BPT 1235 / IR 64	3 9
	MTU 11335	MTU 2077 / IR 64	4 2
	MTU 11898	Swarna / MTU 7014	4 3
	RP 3206-32605	IET 7564 / IET 7946	4 3
	MTU 1199 135-2 1-3	Chaitanya / IET 8371	4 4
	RP 2332 12770-1828	Ratna / ARC 10654	4 8
Multiple Resistance Screening Trial (MRST)			
	RP 3746 26738	—	1 4
	RP 3804 23019	IET 7946/RP 1579-9700	1 5
	SKL 11 39 139-69	W 1263/CR 27 MR 1523	1 9
	BPT 6038	BPT3291/ARC6650	2 2
	KAUM 57 18-1-1	MO 1/MO6	2 6
	BPT 7317	MTU 4870/IR50	2 8
	KAUM 42 6 3	MO 6/POKKALI 372	2 8
Initial Hybrid Rice Trial - 1 (IHRT 1)			
	MNDRH - 1	25 A / IR 44675	3 3
	HRI - 115		4 9

Table 45 Promising entries against whitebacked planthopper

IET No	Designation	Cross	Damage grade on 0-9 scale
National Screening Nursery (NSN - 1)			
13831	JR 82-5-199	IET 5850/JR 75	2 6
14333	SKL 5-5 11-1 62	W 1263/CR 57 MR-1523	2 6
14038	R 5574-11	—	2 6
14431	OR 1015 27	IR 13429 94/Gauri	2 6
14031	OR 764 39	OR 131-1 9/IR 42	2 8
14430	OR 844 11	IR 86 8/Prathap	2 8
13951	NDR 1025 3	C 1064 5/IR 9129 320-3-3-3//IR54	2 9
14105	CN 842-15 5	IR 50/Patnai 23	3 0
Multiple Resistance Screening Trial (MRST)			
	KAUM 42 46 8 1	MO 6 / Pokkali 372	1 0
	KAUM 42 40 4 1	MO 6 / Pokkali 372	1 1
	KAUM 57 18 1 1	MO 1 / MO6	1 1
	SKL 5 11-1 62	W 1263 / CR 57 MR 1523	1 2
	IR 21567	—	1 9
	SKL 11-28 29 55	RPW 6 17 / Eswarakora	2 7
Initial Hybrid Rice Trial - 2 (IHRT 2)			
	—	IR 58025 A / IR 49461 128-3-3-3R	2 0
	—	IR 58025 A / IR 55722 B-B-6-2-2R	2 8
Scented material			
	Ramsail		1 4
	Sonth		1 7
	Lua Nhe		1 7
	Ramjiwain		1 9
	Basmati 6129		2 2
	Dehradun local		2 3
	Basmati		2 4
	Sonth		2 6
	HBC 98		2 9
	Lakho Kuwar		3 0
	Gopal Bhog		3 0
	Padi Empat Bulan 2		3 0

Table 46 Promising entries against brown planthopper and whitebacked planthopper

IET No	Designation	Cross	Damage grade on 0 9 scale BPH	WBPH
National Screening Nursery (NSN - 1)				
14087	RP 1579 23071-1320	RPW 6-17 / ARC 6650	2 4	3 4
14325	RP 3174 1579 1633	IET 8655 / IET 8642	3 5	3 6
13302	OR 853 2	Daya / Sarathi	3 0	3 3
14062	OR 1114-59	Shanker / CR 1014 // Jajati / Panke	3 6	3 6
14298	TNAU 91002	IR 50 / CO43	3 7	4 0
National Screening Nursery (NSN 2)				
14763	SIRI 295	HKR 120 / IET 10719	2 4	3 7
15091	SIRI 193	HKR 120 / ES 18	2 1	3 7
15076	CR 691-47-2	Pusa Basmati Mutant-1	2 7	4 0
15185	OR 1511-10	IR 64 // Sarathi / Birupa	3 7	3 4
15032	OR 1513-3	OR 1045-1-10 / PATHRA	2 9	3 1
15302	NDR 1038 4	Bagri Red / IR 15689-173-1-1-1-3 IR 8990-3-9-3 //N 22	2 9	1 8
15303	NDR 1038 6	Bagri Red / IR 15689 173-1-1-1-3 IR 8990-3 9-3//N 22	2 7	2 2
14941	CRK-7 2-8	CR 1102/CR 1018(2)	2 4	3 4
15274	NDR 96001	IR 66876-13- M 10-1-1-1	3 0	3 5
15276	NDR 96003	IR 66366-M-10 1 1 1	3 4	4 0
15354	B 90 15-3-R	—	3 5	4 0
13762	CSR 88-IR-3	IR 14632-22 3/IR19799-17-3-1-1	3 7	3 8
13765	CSR 88-IR-6	Nonabakra / IR5657 33-2	3 7	2 5
13766	CSR 88-IR-7	Nonabakra / IR5657 33-2	2 6	3 7
15369	VRS 1	IR 40676-B-B-2-2	2 4	1 7
Multiple Resistance Screening Trial (MRST)				
	BPT 6038	BPT 3291 / ARC 6650	2 2	3 3
	KAUM 42-6 3	MO 6 / Pokkali 372	2 8	3 1
	KAUM 57-18-1 1	MO 1 / MO 6	2 6	1 1
	SKL 5 11-1-62	W 1263 / CR 57 MR 1523	3 1	1 2
	SKL 11-28 29-55	RPW 6-17 / Eswarakora	3 8	2 7
	SKL 11-39-139-69	W 1263 / CR 27 MR 1523	1 9	3 3
	IR 21567	—	3 6	1 9

Table 47 Promising germplasm accessions against planthoppers

Brown planthopper (Damage grade upto 3 0)

INRC Nos	9006	9152	9161	9178	9186
INRC Nos	9202	9266	9315	9331	9274

Whitebacked planthopper (Damage grade upto 3 0)

INRC Nos	9107	9134	9135	9136	9143	9152
INRC Nos	9169	9178	9197	9215	9203	9205

Brown planthopper and Whitebacked planthopper (damage grade upto 5 0)

INRC Nos	9056	9078	9133	9135	9136	9152
INRC Nos	9169	9178	9187	9202	9205	9218

Table 48 Promising entries against gall midge biotypes 1 and 4 (showing nil damage)

Gall midge screening trial (GMS)

RGL 3301	WGL 18011 15
RGL 3393	SKL 11 28-29-55
RGL 4233	RP 2932 32339 1854
RP 2882 30105	RP 2724-224 5
RP 3409 73 1	RP 2724-229-8

Multiple resistance screening trial (MRST)

TTB 148-169 2 1-2 1*	SKL 11 39 139 69	RP 3746-26738
WGL 26889*	SKL 33 10-66-92	SKL 2 20 13-28-6
KAUM 42-6-3	SKL 69 9 3 33 33	SKL 5 11-1 62
RGL 3250	SKL 116-16 4-58	SKL 9 13-14-3-34
RGL 3265	CRH-1	SKL 11-28 29 55

Gall Midge Special Screening Trial (GMSS)

RGL 3265	CRH-1	SKL 11 28 29 55
AC 169	INRC 232	INRC 6803
AC 355	INRC 1997	INRC 7247
AC 424	INRC 2324	INRC 7445
AC 630	INRC 3001	INRC 7798
CR 94 MR 1550(RED)	INRC 3021	INRC 8501
NAGRASAL	INRC 5058	INRC 8504
NHTA 8	INRC 5073	INRC 8758
T 10	INRC 5364	INRC 8876
T 1477	INRC 6023	SIAM 29
VELLATHILCHEERA	INRC 6782	VELLUTHACHEERA
ORUMUNDAKAN (M)	AGANNI	LEUANG 152

*Entry retested

Green leafhopper One hundred and eleven entries of International Rice Tungro Nursery were screened against green leafhopper by following standard seed box technique Sixteen entries recorded a damage grade below 3 0 on 0 9 scale Six multiple resistant cultures viz CRM 47 HKR 86 104 HKR 91 102 BPT 6868 IET 13341 and IET 12356 which have been found resistant to GLH in repeated mass screening tests were evaluated for their antibiosis as reflected in the survival of second instar nymphs All the six cultures showed lower survival (16 37%) than resistant check Vikramarya (47%) exhibiting better antibiosis reaction

PEST MANAGEMENT

Evaluation of new insecticides Two granular insecticides and six spray formulations were evaluated in the field against pest complex at DRR Fipronil granules belonging to phenyl pyrazole group (75 g a i /ha) exhibited efficacy against stem borer gall midge and whorl maggot similar to carbofuran (1000 g a i /ha) while carbosulfan granules (1000 g a i /ha) were inferior Among sprays Mitac (300 g a i /ha) was the only insecticide which showed efficacy against stem borer similar to chlorpyriphos (500 g a i /ha) while all others were of lower order Against whorl maggot Mitac and silafluofen (100 g a i /ha) exercised control similar to chlorphyriphos All the granules and sprays registered moderate efficacy against leaf folder The granular insecticides viz carbosulfan and fipronil produced grain yield similar to check insecticide carbofuran Among sprays fipronil Mitac imidacloprid (25 g a i /ha) and Lambda cyhalothrin (12 5 g a i /ha) were on par with chlorpyriphos

Safety of insecticides to natural enemies In an effort to assess the safety of recommended granular and spray formulations to natural enemies two granules viz cartap (750 g a i / ha) and isazophos (500 g a i /ha) and three spray formulations viz cartap (300 g a i /ha) ethofenprox (75 g a i /ha) and triazophos (250 g a i /ha) were included in a co ordinated trial The results revealed that these insecticides exhibited safety to egg parasites of stem borer and predators of planthoppers like spiders mirid bugs and coccinellids similar to check insecticide acephate spray

Evaluation of botanicals in rice pest management In a green house experiment at DRR eight neem formulations with varying azadirachtin concentrations were studied for their growth retardant effects against brown planthopper and whitebacked planthopper LC50 values (as % concentration of the formulations) are presented in Table 49

Table 49 Relative toxicity (LC50) of neem formulations against BPH & WBPH

Formulation	BPH	WBPH
Nimibicidine	1 695	1 353
Neem Azal T/S	0 9616	0 7802
Econeem	2 114	0 5915
Neemgold 4	0 5294	0 5916
Fortune Aza	0 9732	0 9565
Rakshak	1 454	0 5837
Achook	1 317	4 903
Neemax	0 8537	3 979
Neemgold	NT	1 426

NT = Not tested

In a field study at DRR Nimbicidine (a formulation with 300 ppm azadirachtin) at 4% conc and Neem Azal T/S (formulation with 10 000 ppm azadirachtin) at 0 5% conc were alternated with deltamethrin (25 g a i /ha) spray to assess their effect on populations of BPH and its natural enemies like mirid bugs and spiders Nimbicidine when alternated completely annihilated resurgence causing effect of deltamethrin recording 666 BPH/10 hills as compared to deltamethrin alone (1276 BPH/ 10 hills) while untreated control recorded 673 BPH/10 hills In another field study six neem formulations viz Nimbicidine (2%) Neemax (2%) Neemgold 4 (2%) Econeem (0 5%) Neem Azal T/S (0 3%) Fortune Aza (0 5%) were moderately effective against leaf folder rice hispa whorl maggot and stem borer and moderately increased grain yield

Evaluation of biopesticides In a co ordinated experiment three B t formulations viz Delfin 85% Dipel 3 5% and Biolep were evaluated each at 2000 and 1500 g of formulation/ha The overall results showed that B t formulations were moderately effective against stem borer and leaf folder but the efficacy was of lesser order than the insecticide chlorpyriphos (500 g a i /ha)

Natural biological control in rice ecosystem In this trial natural biological control (NBC) with no insecticide application need based protection (NBP) judged by periodic surveillance and economic thresholds as well as schedule based protection (SBP) involving schedule based application of insecticides were compared for pest incidence natural enemy occurrence and grain yield In co ordinated programme at 9 locations higher level of egg parasitism in stem borer was observed at Coimbatore in NBC despite low pest incidence At Aduthurai stem borer damage as well as parasitism were low to moderate Late incidence of gall midge upto 50% was noticed at Pattambi however parasitism remained negligible In case of leaf folder also higher larval parasitism upto 50% was observed in NBC at Coimbatore Spiders dominated among the predators and their populations were significantly higher in NBC and NBP compared to SBP

At DRR the experiment was carried out as early planted trial with BPT 5204 and a late planted trial with Hamsa variety The pest incidence in early planted trial was low (0 6 to 3 9% DH and 1 2 to 4 1% WE) In late planted trial the incidence of gall midge was 24 5% SS in NBC at 30 DAT compared to 10% SS in NBP and 5 6% SS in SBP More or less similar incidence prevailed by 60 DAT However parasitism of gall midge was negligible in all the treatments Stem borer incidence was 7 6% DH in NBC 5 8% DH in NBP and 0 9% DH in SBP at 45 DAT Spider population showed clear increasing trend in NBC and NBP com pared to SBP However SBP showed higher yield than both NBP and NBC The results showed that in situations of low to moderate pest incidence unnecessary insecticide application in schedule based treatments can be avoided However single need based application of insecticide is necessary to maintain yield levels and favourable balance of pest and natural enemy populations

Use of Kairomones in the management of rice insect pests Laboratory studies revealed that susceptible TN1 was more attractive to mirid bug nymphs compared to BPH resistant varieties Among the 9 solvents tested acetone and methanol extracts of TN1 rice plant attracted the maximum number of mirid bugs followed by chloroform and hexane extracts Distilled water ethyl acetate ethyl alcohol and diethyl ether extracts attracted the lowest number of mirid bugs When healthy and damaged TN1 plant extracts were bioassayed for their attractability to mirid bugs

mirid bugs showed highest response to the healthy TN1 plant followed by BPH damaged rice plant and WBPH damaged plant extracts Lowest number of mirid bugs were attracted to GLH infested rice plant extract Among different ages of TN1 acetone extracts of 75 day old plants attracted higher number of mirid bug nymphs compared to younger or older plants and leaf extracts were more attractive than those of stem or panicle Mirid bug nymphs females and males preferred to move toward BPH and GLH honey dew compared to WBPH in choice tests Mirid bug nymphs reached honey dew source of BPH WBPH and GLH faster compared to adults The body extracts from adults and nymphs of BPH were more attractive to nymphs females and males of mirid bugs than GLH and WBPH Mirid bug nymphs and adults preferred BPH and WBPH eggs as compared to GLH eggs in both choice and non-choice experiments in potted rice plants Nymphs of mirid bugs were better predators than adults

Monitoring of yellow stem borer with pheromones Yellow stem borer (YSB) can be monitored with pheromone baited traps more easily than light traps These are economical and can detect the pest at lower population levels than light traps Further monitoring with pheromones can serve as an early warning system of pest invasion useful to identify peak occurrence of YSB to formulate control strategies and enable us to come up with trap catch based ETL Therefore further standardisation of monitoring with pheromones was continued Three sleeve traps/acre kept in a triangular set up and loaded with 2 mg of YSB pheromone per trap were observed every week for the male moth catches The results revealed significant correlation between trap catches of male moths and infestation in the field Peak YSB infestation occurred 2 weeks after sudden rise in trap catch both in vegetative and reproductive stages (Fig 12)

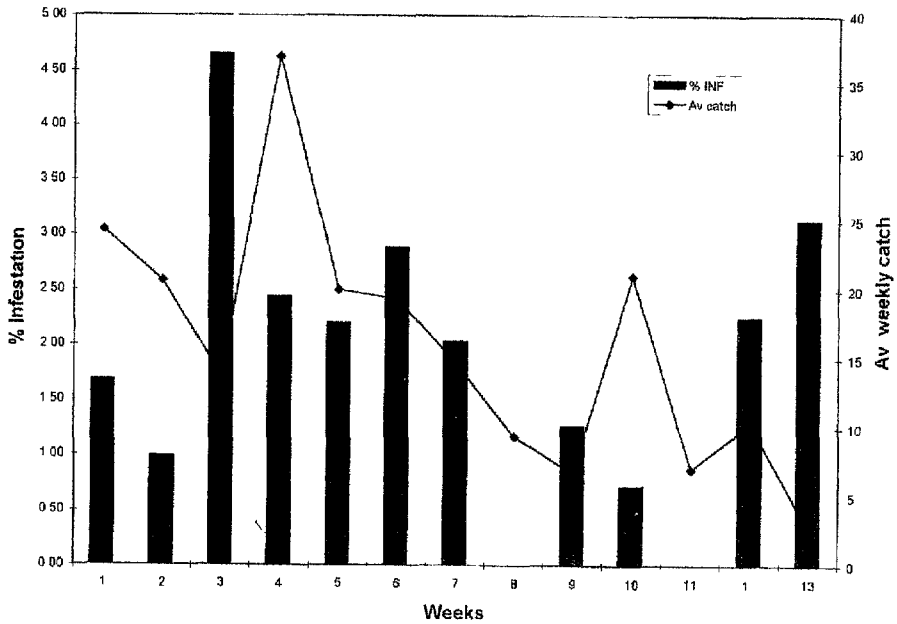


Fig 12 Monitoring of YSB through pheromone traps

Mass trapping of yellow stem borer In previous years mass trapping of YSB with pheromone baited traps with 5 mg of pheromone/trap with 20 traps/ha was carried out at three co operating centres As there was significant reduction in the damage in treated areas as compared to plots with farmers practice further fine tuning of the technique was continued A trial was carried out in Medchal village to optimize the time of pheromone application in the field In the normal practice deploying the traps immediately after planting results in trampling of freshly transplanted seedlings Therefore this practice was compared with setting up traps one month after transplanting and farmers practice The results revealed no significant difference between installation of traps immediately after planting and one month after planting However both the treatments were significantly superior to farmers practice (Table 50)

In another trial three treatments viz (i) pheromone application (ii) pheromone application + need based insecticide treatment and (iii) farmers practice were compared Each treatment had 4 ha area First two treatments received pheromone application as per the normal recommendation while the second treatment received additional two sprays of conventional insecticides based on ETLs of YSB Though stem borer damage in the first two treatments was not significantly different but lower than FP This reveals the potentiality of pheromone mass trapping against YSB and possibility of drastically reducing the cost of conventional insecticide applications (Table 51)

Mass trapping on whole village basis was undertaken in Medchal (Ranga Reddy District) to bring this technology to the farmers door step An approximate area of 350 acres comprising some 100 farmers with holdings ranging from 2 10 acres was covered Three other small villages - Athivelli Railapur and Girampur adopting farmers practice were taken as control Fifty sampling plots were randomly selected and per cent infestation was recorded at 10 days interval starting from 25 DAT both in treatment and control Population of YSB moths in treatment and control areas was observed for a period of ten days by installing

Table 50 Optimization of time of trap installation, *Kharif* 96

Treatments	% YSB infestation		Yield
	%Dead Hearts	%White Ears	(Kg/ha)
Immediately after transplanting	6 18	2 67	4348
One month after transplanting	1 07	1 93	4348
Farmer s practice	8 08	12 29	3628

Table 51 Performance of pheromone traps through mass trapping, *Kharif* 1996

Treatments	% YSB infestation		Yield
	%Dead Hearts	%White Ears	(Kg/ha)
Phero only	11 85	5	4800
Phero + Need Based Insecticide Application	16 79	4 61	4520
Farmers Practice	21 87	8 52	4080

gas lights Males and females were counted at each hour interval Overall infestation was significantly lower in Medchal village as compared to villages adopting farmers practice (Table 52)

Population studies with light trap showed very low population of YSB in pheromone treated village compared to control and peak activity of moths was observed between 9 11 pm (Fig 13 and 14)

Table 52 Evaluation of mass trapping through pheromone traps on whole village basis *Rabi* 1997

Treatments	YSB infestation		Yield
	%Dead Hearts	%White Ears	(Kg/ha)
Pheromone Treated	0 04	13 91	6380
Farmers Practice	1 09	24 11	4932

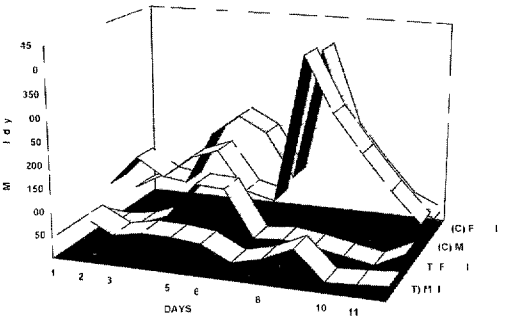


Fig 14 Light trap catches of YSB moths in pheromone mass trapping trial

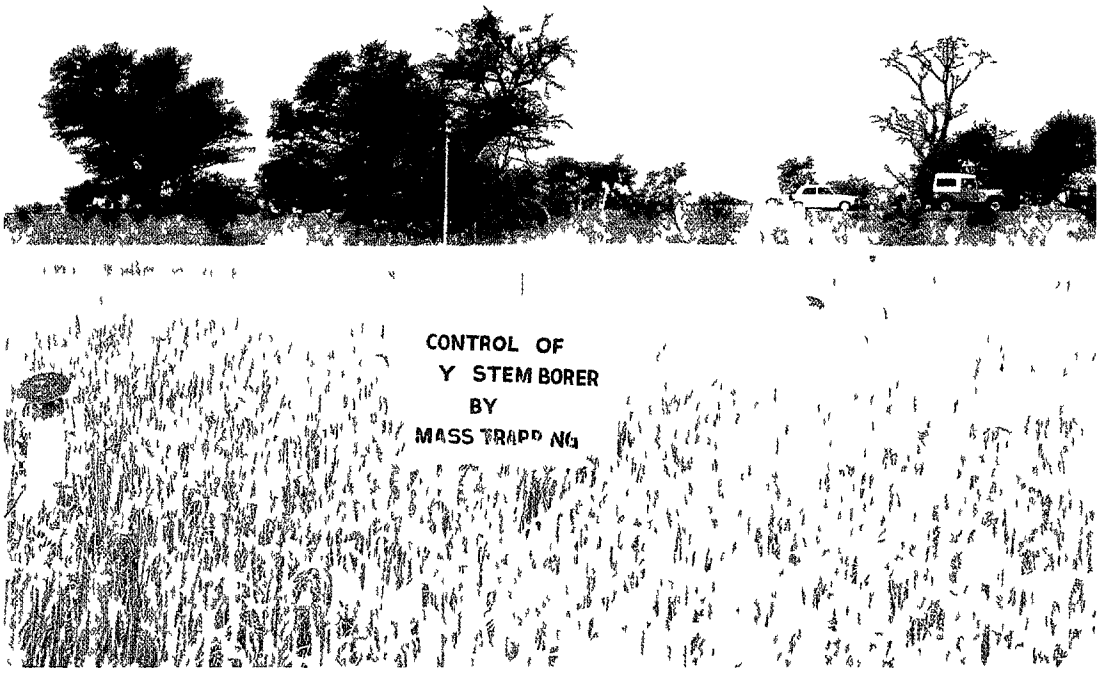


Fig 13 Mass trapping of YSB through pheromone traps

Mating disruption

Earlier trials on mating disruption were carried out by using imported controlled release formulation (CRF) In order to develop indigenous technology this year trial involved two CRFs from IICT and one from DRR's own material CRFs were placed at the rate of 500 point sources/ha in a 4 x 5 m lattice with the help of bamboo sticks The population of moths was assessed at weekly intervals with the help of pheromone baited sleeve traps These indigenous materials caused 91 3 to 96 5% communication disruption index (CDI)

Ecological and biological studies

Performance of multiple resistant cultures under protected and unprotected conditions

The objective of this trial is to assess the yield potential of some of the multiple resistant cultures with confirmed performance and also some pre-release cultures in relation to their reaction to insect pests During *Kharif* 1996 field performance of five multiple resistant cultures viz IET 12875 Narmada, SKL 11 28 29-55, RP 3179 1462 and RP 3174-1631 alongwith Jaya as susceptible check was studied under protected and unprotected conditions at DRR Incidence of gall midge, leaf folder and stem borer at 50 DAT was very low (Table 53) Although stem borer incidence at heading stage was moderate, the differences among the treatments are not significant in case of IET 12875 indicating broad based resistance and stability in yield potential

Studies on parasitic nematode problems of rice and rice based cropping systems

A survey was conducted in West Godavari District of Andhra Pradesh in collaboration with Entomologist, Agricultural Research Station, Maruteru and State Department of Agriculture

Table 53 Incidence of insect pests and grain yield in multiple resistant cultures - 1996

Variety/ Treatment	STEM BORER % DH 50 DAT	STEM BORER % WE	GM (% SS) 50 DAT	WM ADL/10 h 50 DAT	LF ADL/10h 50 DAT	THRIPS ADL/10h 50DAT	YIELD kg/ha
V1 T1	4 3a	15 7a	2 8ab	17 0a	2 7a	14 3ab	4169ab
V1 T2	3 1a	17 2a	0 5a	47 0c	5 3a	29 7c	3971bc
V2 T1	2 1a	9 8a	1 9ab	15 7a	0 3a	12 3ab	3177d
V2 T2	1 9a	11 1a	4 3bc	57 7d	1 7a	32 0d	2647e
V3 T1	2 7a	15 7a	3 1ab	20 3a	1 0a	11 7a	2581ef
V3 T2	4 1a	15 1a	1 5ab	33 3bc	4 7a	34 7d	2118fg
V4 T1	3 4a	13 9a	0 3a	18 7a	0 7a	12 0ab	1522fg
V4 T2	6 5a	24 2a	0 5a	43 3cd	3 3a	33 0d	596h
V5 T1	3 4a	11 5a	4 4bc	15 7a	1 7a	15 3ab	4765a
V5 T2	4 6a	14 0a	7 7c	54 0d	5 7a	38 0d	3640cd
V6 T1	3 6a	22 1a	7 5c	22 7ab	3 0a	18 3bc	3177de
V6 T2	2 9a	18 7a	4 3bc	46 0cd	5 0a	27 3cd	1787g

T1 Need based protection
T2 Unprotected

V1 IET 12875
V2 Narmada
V3 SKL 11 28 29 55
V4 RP 3179 1462
V5 RP 3174 1631
V6 Jaya

The survey revealed wide spread occurrence of an annelid in rice fields which was reported to be the causal organism of the stunted growth of the crop The annelid was identified as Malbaria sulcata On processing the samples it was observed that the plants developed galls containing the nematode Meloidogyne graminicola The annelid multiplied equally with or without rice plants The complex of annelid nematode invites an intensive study Besides root-knot nematode mixed population of *Hirschmanniella mucronata* and *H oryzae* was recorded in West Godavari District Andhra Pradesh

To identify resistant germplasm to parasitic nematodes of rice entries of MRST (116) restorers for CMS lines (345) NSN 1 (190) and E asmati (36) were screened for resistance to Meloidogyne graminicola and all of them were found to be susceptible

To study the influence of chemicals on the root nematode, *Hirschmanniella mucronata* root nematode population buildup was followed in new insecticide trial of Entomology Department in which eleven treatments were introduced Out of these treatments three were granular formulations and seven were spray formulations with an untreated control The granular formulations were applied at 15 35 and 55 DAT and the spray formulations on 15, 35 55 and 75 DAT The observations recorded at maximum tillering stage (60 DAT) revealed that nematode populations in soil were on par in all the treatments In the roots carbofuran followed by Marshall recorded the lowest number of nematodes followed by Confidor and Durmet treatments The untreated control, Silafluofen, RH 2485 and fipronil granular and spray treatments recorded the highest populations (Table 54)

To assess the influence of the manuring on the build up of *H mucronata* in rice soil root samples were collected from soil science experiment which was laid out in a split plot design consisting of three main plots viz dhaincha, green gram sunhemp grown and incorporated and four sub plots viz straw @ 2 5 t/ha + 100 kg N as urea straw @ 5 t/ha + 100 kg N as urea 100 kg N as urea and control Observations revealed that the treatments in dhaincha and sunhemp in the main plots with straw @ 2 5 and 5 t/ha + 100 N as urea recorded the least number of nematodes The main plot with control and sub plot with 100 kg N/ha as urea recorded significantly higher number of nematodes

Table 54 Influence of chemicals on root nematode populations at maximum tillering stage

Treatment	Dosage (g a i /ha)	Nematode Populations Soil	Root
1 Marshal	1000	35 67a	175 00b
2 Fipronil	75	17 00a	1554 00e
3 Furadan	1000	34 00a	103 33a
4 DD 136	6 25	35 67a	1046 67d
5 Fipronil	50	51 67a	1303 33de
6 Mitac	300	66 67a	1030 00d
7 Confidor	25	36 00a	616 67c
8 Silafluofen	100	46 00a	1273 33de
9 RH 2485	100	57 00a	1176 67de
10 Karate	12 5	33 33a	1215 00d
11 Durmet	500	35 00a	510 00c
12 Untreated control		30 00a	1383 33e

PLANT PATHOLOGY

Co-ordinated Pathology Research Programme

Host Plant Resistance Six national screening nurseries and two international nurseries comprising 1346 advanced breeding lines, new rice hybrids and others were evaluated against major rice diseases at 38 locations The entries with broad spectrum of resistance for each disease in different nurseries are given in (Table 55)

New fungicides evaluation

Blast The relative efficacy of six fungicides were evaluated at sixteen blast endemic locations None were comparable to check fungicide Beam 75 WP However, Octave 50 WP and Opus 12 5 SC were found promising at a few locations

Sheath blight Among the fungicides evaluated at 11 locations Opus 12 5 SC and Atemi 50 SL (new triazole group) were highly effective against sheath blight and comparable to Tilt 25 EC to biological efficacy (Fig 15)

False smut The Blue Copper 50 and chlorothalonil 40 were effective in reducing false smut disease

Table 55 Low scoring entries of national screening against major diseases

	Resistant Entries (IET Nos)
Blast	NSN1 14101 14102, 14105, 14208
	NSN2 14775 14627 13695, 14803 15335, 13769 and 15456
	NSNH 13477, 14158, 14148, 15046
Brown Spot	NSN1 14074 14077, 14086 14436, 14444
	NSN2 15026, 15034 15393
Sheath rot	NSN1 14720, 14074, 14332 14396 and 13650
	NSN2 15207, 14935 15222 and 15241
BLB	NSN1 14444 NSN2 15285 and HKR 93
Tungro Disease	DSN 13358 SKL 2 20 13-28-6 and CRM 53
	IRTN PT 88 ARC10343 and ARC 11554
	NSN1 14301 and 14306

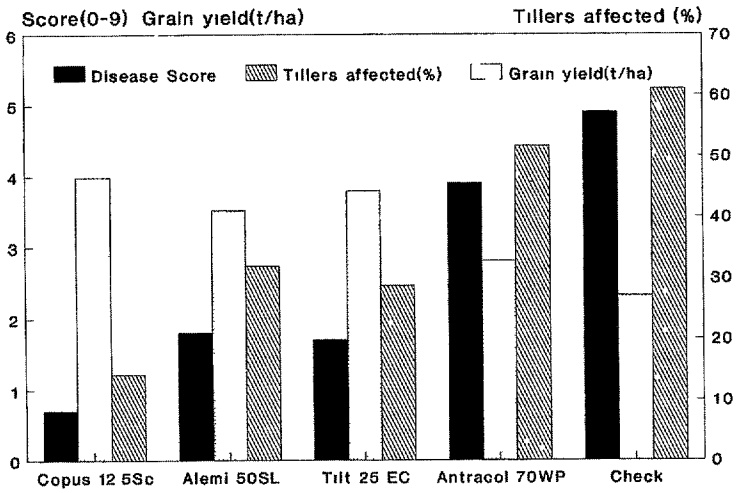


Fig 15 Effect of fungicides on sheath blight

Integrated disease management

This trial was evaluated at 8 locations Blast was the target disease A combination of resistant varieties and need based fungicide application significantly reduced blast disease

LEAD RESEARCH

Host Plant Resistance

Evaluation of Rice Germplasm for Biotic Stresses An adhoc Research Project funded by the ICAR for evaluation of rice germplasm for biotic stresses was conceived and implemented since 1993 with the objective to evaluate the existing germplasm against major pests and diseases documenting the results and make available the new genetic resources for use The network co ordinated by the Directorate comprises of two lead centres viz NBPGR and IGKVV Raipur and 13 hot spot centres viz , Almora Kapurthala Sambalpur, Raipur Jagdalpur Pondicherry Maruteru, Srikakulam Mandya Aduthurai Moncompu Ponnampet and Hyderabad

During 1996 3000 accessions received from Raipur were evaluated for blast and bacterial leaf blight at DRR and other locations Preliminary results obtained from tests at DRR indicate that the following entries are promising (Table 56 & Fig 16)

Table 56 Low scoring entries in germplasm for major rice diseases

Disease	Locations	Resistant accessions
Leaf blast	Aduthurai, Almora, DRR Jagdalpur, Ponnampet	INRC 9023, 9364 9593 9669, 9858 9888 9927 10332, 10505, 10573
BLB	Kapurthala Maruteru, Raipur DRR	INRC 9336, 10286 10306, 10430
Sheath blight	Maruteru, Kapurthala Moncompu	INRC 9262 9920 10829, 10888 10970 11000

Fig 16 Germplasm evaluation against BLB at Kapurthala

Slow Blasting Slow blasting resistance is a quantitative trait and is environmentally sensitive Rice genotypes phenotypically express reduced differential infectivity harbouring susceptible lesions The relative ability of 22 promising rice genotypes to reduce blast disease progress was studied Among the rice genotypes five entries had shown slower progress of the disease IET Nos 12863 and 13188 had low infections at early stages and arrested disease progress at later stages as well While IET 9994 had a relatively steep increase of the disease at early stages but the epidemic progress was arrested at later stages (Fig 17)

Pathogenic Variability Studies

Bacterial blight Bacterial leaf blight caused by *Xanthomonas oryzae pv oryzae* is one of the serious disease in India In previous work several methods for conducting molecular genetic studies on Indian isolates were standardised and DNA finger printing and pathotypic of Xoo isolates collected from different locations in India Virulence genes flow of Xoo pathogen from wild habitats to cultivated habitats was studied Pathogenic isolates of Xoo were collected from wild rice habitats away from conventional rice fields and as well from cultivators fields in Andhra Pradesh Genetic and virulence structure of wild rice isolates originated in Deccan Plateau (*O nivara*) (Fig 18) and cultivated rice isolates were analysed

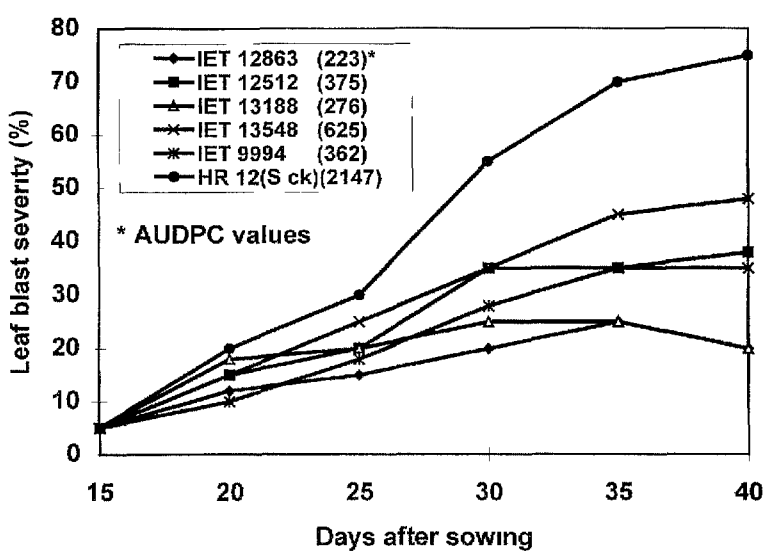


Fig 17 Progress of leaf blast on selected rice varieties

Interestingly in both system rice pathotypes and genetic lineages were similar indicating that Xoo is not introduced pathogen from elsewhere and evolutionary variation is minimal and gene flow must have occurred from wild rices to cultivated rices in different parts of the country (Table 57)

Sheath blight Aggressiveness of 20 *R solani* isolates of rice was evaluated on IR50 Among the isolates tested six isolates viz MCP KPL TTB CRR MTU and PTB were highly aggressive (75 100% Disease index) 9 were moderately aggressive (51-74% Disease index) 3 were less aggressive (26 50% Disease index) and two isolates from Almora (ALM) and R S Pura (RSP) did not produce any disease Of these 20 isolates 15 isolates were sent to International Mycological Institute Surrey United Kingdom for identification IMI identified that the isolate from Almora as *Rhizoctonia oryzae sativae* (the causal agent of *Rhizoctonia* sheath rot disease of rice) The other 14 isolates were identified as *R solani* The highly aggressive isolates on TN 1 were inoculated on a set of known susceptible moderately resistant varieties/accessions (Table 58) The results showed that TN1 IR50 and Kavya were susceptible to highly susceptible to the test isolates with SI of 7 2 to 8 1 while Vikramarya Pankaj and Swarnadhan were moderately susceptible (SI 5 4 to 6 0) ARC cultures showed a low level of diseases to most of the isolates (Table 58)

Table 57 Pathogenicity pattern of isolates of bacterial blight originated from wild and cultivated rices in A P

Isolate	Reaction pattern on variety		
	HSWR	DRR/RNR	WGL 1
IET 8585	3	3	3
BJ1	2	3	3
DV 85	2	3	3
IR 20	7	7	6
Cempocelate	8	6	6
Sayaphal	3	4	4
TN1	8	8	8

Values of 2 replicates

NRWR wild rice isolate *O nivara* - Himayatsagar Lake area R R Dist

WGL7 Pakala Warangal area Krishnaveni cultivar

DR/RNR - DRR farm Rajendranagar Hybrid rice plots

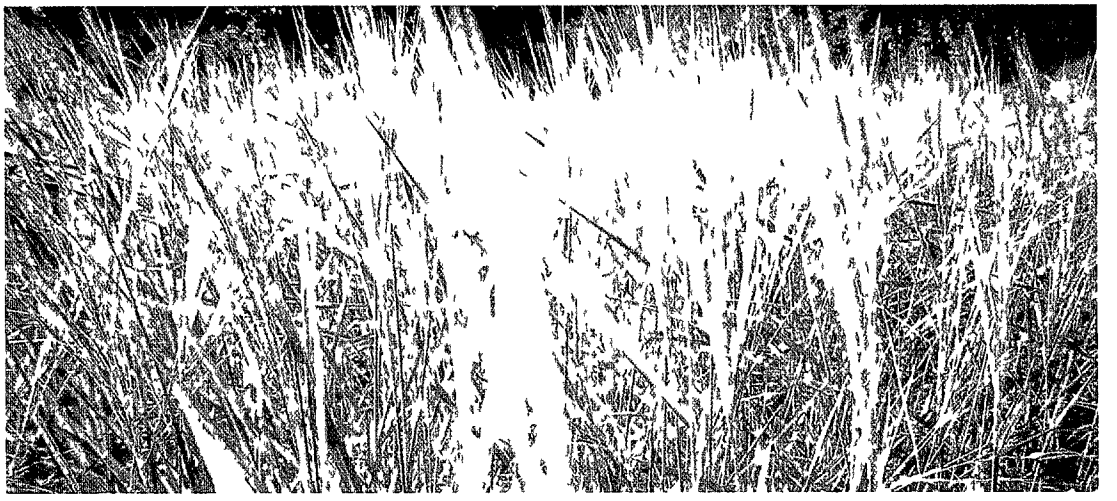


Fig 18 Wild rice habitat for X oryzae in Telengana region

DISEASE MANAGEMENT

Effect of silica on sheath blight disease

Seedlings of TN(1) were raised in soils amended with silicon and inoculated with sheath blight pathogen *R solani* at boot stage to study the effect of this additional supply of this nutrient on sheath blight disease severity and grain yield Rice hull ash which contains approximately 94 percent silicon was used as source material at 20 40 and 60 g/pot (14 x 16 cm size) and silicon dioxide the pure form of silica was used at 2 g/pot Unamended soil served as control (Table 59)

Silica application reduced disease severity and increased the grain yield and percent grain filled Rice hull ash at 60 g/pot was found to be highly effective as compared to other treatments

Table 58 Virulence pattern of *R solani* isolates of rice

ISOLATES	VARIETIES									Virulence Index (VI)
	TN1	IR50	Kavya	Vikramarya	Pankaj	Swarnadhan	ARC 10639	ARC 10646	Dubraj	
KPL	8 5	8 7	7 0	7 0	5 5	6 0	5 5	5 3	5 0	6 50
MCP	9 0	8 7	8 5	7 3	6 3	7 0	5 0	4 5	4 5	6 76
TTB	8 5	7 3	7 0	7 0	6 5	5 0	5 3	5 3	5 0	6 32
MTU	7 3	7 3	7 0	5 3	5 0	5 0	5 3	5 3	5 0	5 83
CRR	9 0	7 0	7 0	5 0	5 3	5 3	5 3	5 0	4 3	5 91
PTB	7 0	7 3	7 0	5 3	5 3	5 0	5 0	5 3	4 0	5 69
RNR	7 3	7 5	7 0	5 3	5 3	5 0	4 3	4 3	4 0	5 56
SUSCEPTIBILITY INDEX (S I)	8 09	7 69	7 21	6 03	5 60	5 47	5 10	5 00	4 54	

Table 59 Effect of Ash and silicon on sheath blight disease severity

Treatment	Disease severity	Grain wt/plant	% of grain filling
Ash (20g/pot)	3 9	4 28	48 51
Ash (40g/pot)	3 3	4 99	47 06
Ash (60g/pot)	3 1	5 58	63 01
Silica (2g/pot)	3 2	3 52	41 77
Control	6 1	2 48	42 90

Resistance induction through chemicals

Inducing resistance to sheath blight disease was tested in cultivar TN (1) through treatment with four chemicals viz salicylic acid IAA, benjoic acid and cycloheximide The chemicals were used at specified concentrations at 10-3M for all barring cycloheximide (10-5M and 10-6M), for soaking seeds for 48 hrs or seedling root dipping for 2 hrs Although both treatments reduced the disease severity and increased the grain yield/pot the seed soaking was found to be more effective than root dipping Among the four chemicals salicylic acid & cycloheximide 10 5M were highly effective than rest of the chemicals (Fig 19)

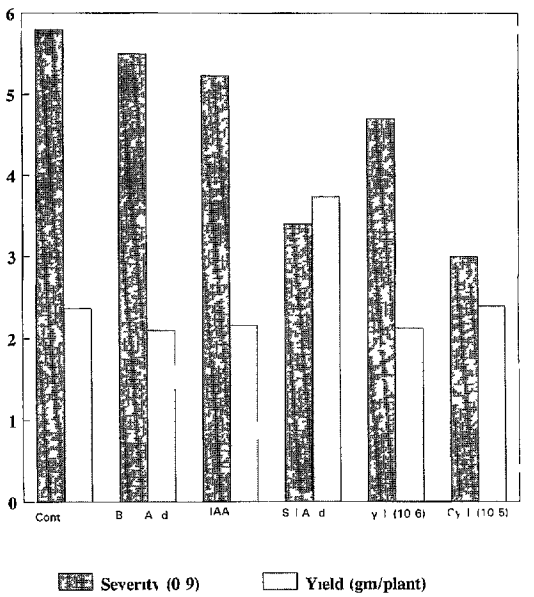


Fig 19 Effect of chemicals on sheath blight

Production Oriented Survey

During 1996 1997 Production Oriented Survey was conducted in 13 states viz Himachal Pradesh Haryana Uttar Pradesh Bihar Madhya Pradesh West Bengal Orissa, Andhra Pradesh Tamilnadu Karnataka Kerala, Maharashtra and Gujarat Sixty six scientists/extension staff surveyed 72 major rice producing states in the country The survey indicated that the country as a whole experienced favourable climatic conditions for rice crop The *Kharif* 1996 output is estimated to be 70 6 mt Favourable monsoon throughout the country with 81% of the districts received normal rainfall However deficient and scanty rainfall resulted drought in Vidarbha region of Maharashtra and Orissa states In contrast because of two severe cyclones in Bay of Bengal during October November the rice crop was affected adversely by floods in Coastal Andhra Pradesh and parts of Tamilnadu resulting in severe crop damage

Outbreak of gall midge was noticed in Kuttanad area of Kerala bacterial leaf blight in parts of Punjab Haryana and Andhra Pradesh and severe stem borer incidence in Punjab and Haryana Among the abiotic factors low use of N fertilizers is a major production constraint in Bihar and Orissa The summary of the observation are presented in (Table 60)

Table 60 Biotic constraints (diseases & insect pests) in different states in India during 1996

Name of the State	BL	BS	SHB	SHR	FS	GD	BB	BPH	WBPH	CW	GM	HIS	LF	GLH	SB	WM
	Diseases									Insects						
Haryana	M			M	L		S		M				M			
Himachal Pradesh	M	M	L	L	M	M							L		L	
Uttar Pradesh	S	L	L	L	L	L	L					L	L	L	S	L
Andhra Pradesh (Telengana)	S		S	M	M		S	M			M	M	M		M S	
Karnataka	S		L	L	L		L	L		L	S		L			S
Kerala											S					
Tamil Nadu	M	M	M				M						M S		M	
Bihar	L	M		M			L			M					M	L
Madhya Pradesh	S		T	S			L	T	T		T					
Orissa	M		M	M			M	M		M	M	M	S		M	
West Bengal	L	L	L	T			L	L					L	L	L	
Gujarat	L					S	S		S				M		M	
Tamil Nadu II		M	M	L		M	L	L					L	L	L	
Maharashtra	L				T		M	L		L			L		M	

L low M moderate S severe Bl blast BS brown spot ShB sheath blight ShR sheath rot FS False Smut GD Grain discolouration BB Bacterial Blight BPH brown planthopper WBPH whitebacked planthopper CW case worm GM gall midge HIS hispa LF leaf folder GLH green leafhopper SB stem borer WM whorl maggot

COMMUNICATION AND TRAINING CENTRE

A Training

During the year 1996-97 in all nine need based and skill oriented trainings on various aspects of Rice Production Technology were organised A total number of 139 senior level extension functionaries from different state agricultural departments (SADs) technical and marketing executives from public and private sector agro input agencies (AIAs) were benefited by participating in the training programmes Details are given in the (Table 61)

The main focus of all training programme was increasing productivity of rice in the irrigated ecosystem In all programmes, emphasis was on reducing the cost of production, optimizing the resources and increasing the productivity on sustainable basis As the frontier technologies are generated to tackle emerging a new training programme on Hybrid Rice Production problems including the seed production was designed and offered to the SDAs for the first time

Out of nine programmes two programmes viz , 1) Integrated Nutrient Management (INM) in Rice and 2) Rice Based Cropping Systems (RBCS) were sponsored by Directorate of Extension (DoE), Govt Of India, New Delhi Two specialised workshops on Rice Production Technology (RPT) for irrigated ecosystem and Integrated Pest Management (IPM) in Rice were organized under Advanced Training Centre on Rice

Andhra Pradesh topped the list with 46 participants (33%) out of the total 139 participants The other states with considerable participation were Maharashtra, Karnataka Bihar, Tamil Nadu and Madhya Pradesh with 12% 11 5%, 10%, 8% and 5% respectively

Out of the 139 participants in all the programmes the share of State Agricultural Departments was 62 59% The Agro-Input Agencies (AIAs) were in second position with 22 3% share followed by State Agricultural Universities with 15 11% The majority of the participants from State Agricultural Departments were Agricultural Officers (40 20) followed by Assistant Directors of Agriculture (25 29%) and Subject Matter Specialists (17 54%) Nearly 7% of the participants were district level officers From State Agricultural Universities (SAUs) Associate Professors Assistant Professors and Subject Matter Specialists had almost equal share in participation In case of Agro Input Agencies (AIAs) majority of them were technical and marketing executives followed by managers

B Extension activities and exhibitions

During the period under report a total number of 1 781 visitors were exposed to different aspects of Rice Production Technology (RPT) Among the visitors 467 were scientists and extension officials from various parts of the country 625 were students from Agricultural Universities viz Andhra Pradesh Kerala Tamil Nadu, Karnataka Maharashtra etc 672 were farmers from Andhra Pradesh Maharashtra Punjab, Mizoram etc and 15 were from different countries viz , Russia Nigeria Bhutan Botswana Singapore Japan Zambia and Cambodia

The CTC participated in a Kisanmela organised by Dept of Agriculture, Andhra Pradesh at Keesrgutta R R Dist on March 7 9th 1997 On this occasion, an exhibition on Rice Production Technology (RPT) was organised in which the High Yielding Varieties (HYVs) like Phalguna Krishna Hamsa, Pusa Basmati Kasturi were highlighted About 3000 farmers were benefited by visiting DRR stall They were exposed to the improved package of practices of rice cultivation i e , crop improvement fertilizer and integrated nutrient management and integrated pest and disease management (Fig 20)

Table 61 Particulars of seminars cum workshop-training on rice organised from April 1996 to March 1997

S No	Name of training	Sponsored by	Date and Duration	Participants No	Statewise	Designation wise
1	Integrated Pest Management In Rice (IPM)	A I A	June 22–06 1996 6 days	14	Maha 1 TN 2 Kar 4 WB 1 AP 6	Executives of Agro Input Agencies (AIAs) 14
2	Rice Production Technology (RPT)	ATC	July 02 06 1996 5 days	14	AP 4 HP2 Mah 3 Hary 1 TN1 Kar 1 Kerala 2	ADA 4 ASSo Pro 2 Asst Agro 1 Rice Path 1 SMS 3 DDa 1 Asst Prof 1 AO 1
3	Integrated Nutrient Management in Rice(INM)	DoE	Aug 12 24 1996 2 weeks	23	AP 9 Mah 6 Kar 1 Har 1 HP 1 MP 1 TN 2 Nagaland 2	AO 13 SMS 3 Assoc Prof 2 AES 1 AAO 1 DDA 1 DAO 2
4	Rice Based Cropping Systems(RBCS)	DoE	August 30 Sept 12 1996	20	MP 5 Mah 3, Guj 1 Pb 2 Orissa 1 AP 3 Kar 1 TN 2 Nagaland 1 UP 1	Agronomist 1 Tag Assoc 1 Tag Organizer 3 SDAO 2 AO 4 SMS 1 DEO 3 ADA 3 Breeder 1 JDA 1
5	Integrated Pest Management Rice(IPM)	ATC	Sept 19 23, 1996 5 days	12	AP 2 Guj 1 Kar 3 TN 2 MAH 1 GOA 1 KER 2	Trg Assoc 1 ADA 4 AO 3 SMS 1 Asst Prof 2 Assoc Prof 1
6	Hybrid Rice Seed Production Technology(HRPT)	DRR	Oct 4 9 1996, 6 days	21	AP 14 Kar 2 WB 1 MAH 1 UP 2 GUJ 1	Executives of AIAs 21
7	Hybrid Rice Seed Production Technology	DRD Patna	Oct 15 17 1996 3 days	11	AP 2 KAR 2 WB 1 MAH 2 MP 1	DDA 2 SMS 4 ADA 2 ADO 1 SDAO 1 AO 1
8	RPT for Irrigated Ecosystem (RPT)	Dept of Agriculture Ranchi	Nov 20 Dec 3 1996 2 weeks 3	14	Bihar 14	AEO 4 SrAEO 7 SDAO 1 SAO 1 Leave Agri Officer 1
9	Rice Production Technology(RPT)	RDR Patna	Jan 21 23 1997 3 days	10	AP 6 Kar 4	ADA 7 AO 1 JDA 1 DDA 1
		Total		**139**		

Hindi Week Celebration

Official language implementation committee formation An official language implementation committee was formed under the chairmanship of Dr K Krishnaiah The members Drs S P Singh Ilyas Ahmed Mangal Sain and Sri Veeraswamy of the committee met on 28 5 96 and discussed several issues related to the implementation of official language at DRR

The following activities were undertaken

For enhancement of Hindi vocabulary for DRR staff every day one Hindi word with its meaning and transliteration were written on two white boards All the name plates of Scientists and other staff were made bilingual and official letterhead was printed in Hindi and English About 25 officials who were not knowing Hindi well were trained by organising the Hindi 'Prabodh course with the help of a Hindi teacher deputed from Hindi teaching Scheme Government of India Basheerbagh Hyderabad from January to May 1997

Hindi week was celebrated at DRR from 10 17 September 1996 with the help of Committee Members of Hindi Sapthah Samarooh Committee to create interest among the DRR staff towards official language (Hindi) Various competitions in Hindi viz Essay Competitions Elocution Extempore Speach Quiz etc were conducted In all the competition DRR staff enthusiastically participated On 17th September 1996 Hindi Week closing ceremony was organised under the Chairmanship of Dr K Krishnaiah and Chief Guest Shri V Anjaneya Sharma Former Register Dakshin Bharat Hindi Prachar Sabha Khairtabad Hyderabad and prizes were distributed to winners of Quiz competition

Fig 20 Hon ble Minister Sri T Devender Goud Visiting DRR stall in Rytusadassu organised by Dept of Agriculture at Keesaragutta R R Dist A P State

INSTITUTIONAL ACTIVITIES

Research Advisory Committee Meeting

The second meeting of the Research Advisory Committee of the Directorate of Rice Research was held on September 17 1996 at DRR Hyderabad under the Chairmanship of Dr A Appa Rao Ex Vice Chancellor Andhra Pradesh Agricultural University, Hyderabad The following members of the RAC were present at the meeting

Dr I C Mahapatra *Ex Vice Chancellor OUAT Bhubaneshwar*

Dr R Seetharaman *Ex Project Director DRR Hyderabad*

Dr I V Subba Rao *Ex Director of Research APAU Hyderabad*

Sri Hameed Khan *New Delhi*

Dr K Krishnaiah *Project Director DRR Hyderabad*

Dr N P Sarma *Principal Scientist DRR Hyderabad*

The committee suggested that DRR should play the role of lead resource centre sharply focusing attention on problem of irrigated rice and carryout more sophisticated type of work that cannot be handled by others at Regional Research Stations or SAUs In view of the higher level of skills and expertise available DRR should tackle special problems that cannot easily be solved by undertaking research in specific areas

Third International Symposium on Hybrid Rice

The third international symposium on hybrid rice with the major theme "Enhancement and sustenance of Hybrid Rice Technology" was held at Hyderabad during 14-16 November 1996 About 150 Indian and 50 foreign delegates from twenty countries participated in the symposium In six different sessions various issues related to hybrid rice breeding seed production, cultivation and application of novel approaches to enhance the level of heterosis were deliberated and discussed (Fig 21 a)

Fifth Annual Meeting of National Rice Biotechnology Network, November 13-16, 1996 held at New Delhi

The fifth annual meeting of National Rice Biotechnology Network (NRBN) was held at New Delhi November 13-16, 1996 prior to 2nd International Crop Science Congress as a satellite meeting More than 150 scientists took part in the deliberations the meeting reviewed the status of research and progress in ongoing National programmes

Annual Rice Group Meetings

The XXXII Annual Rice Group Meetings was held at Coimbatore Tamilnadu from 15th to 18th April 1997 More than 400 delegates attended the meeting and reviewed the progress made in the AICRIP and formulated 1997 1998 co-ordinated and network research programme (Fig 21b)

Fig 21 a Participants of International Hybrid Rice Conference held at Hyderabad on November 14 16 1996

Fig 21 b XXXII Annual rice group meeting 15 18 April 1997 held at TNAU Coimbatore

VISITS AND TRAINING

Seminar/Symposia/Workshop/Meetings attended by the Scientists during 1996-97 (National)

Name of the scientist	Name of the Seminar/Workshop	Venue & Date	Purpose of attendance
K Krishnaiah A PK Reddy M Ilyas Ahmed N P Sarma Padmaja Rao A V Rao I C Pasalu	CRRI Golden Jubilee Rainfed rice for sustainable food Symposium security	Cuttack Sep 23 25 96	To present paper
K Krishhaiah A PK Reddy M Ilyas Ahmed N PSarma I C Pasalu	Inida IRRI Dialogue	New Delhi Sep 27 29 96	To present paper
M Ilyas Ahmed N P Sharma	2nd International Crop Science Congress	New Delhi Nov 17 23 96	To present papers
M Ilyas Ahmed S V Subbaiah	National Symposium on Technology advancement in rice production	Vellanikkara Kerla 17 19 June 1996	Presentation of papers
K Krishnaiah A PK Reddy M Ilyas Ahmed B C Viraktamath M S Ramesh C H M Vijayakumar N P Sarma S M Balachandran Arti Pothukunchy Padmaja Rao Raghveer Rao S V Subbaiah S P Singh R M Kumar B Sree Devi	3rd International Symposium on Hybrid Rice	Hyderabad Nov 14 16 1996	To present papers and Posters
N P Sarma Arti Pothukuchy	National Rice Biotechnology Network 5th Annual Meeting	ICGEB New Delhi 13 16 Nov 1996	For organising the meeting and Presenting Annual Progress Report
K Krishnaiah N P Sarma I C Pasalu U P Rao M Ilyas Ahmed	2nd International Crop Science Congress	Vigyan Bhavan New Delhi 17 21 Nov 1996	To present posters
N P Sarma S M Balachandran Arti Pothukuchy	National Seminar on New Vistas in Plant Bio technology	Osmaina University 20 21 Dec 1996	For Paper Presentation
Kesava Reddy	GCTE Group Discussion	IISC Bangalore Sept 5 1996	To Present data base on response of rice to climatic variables
S V Subbaiah S P Singh B Sree Devi	IV Symposium on Resou rce Management for for Maximization of Crop Production	APAU Hyderabad May 14 15 1996	Participation & Presentation
S P Singh	All India Co ordinated Workshop of Cropping System Directorate	Kumargung Faizabad(U P)	Participation
	* Rice Wheat Meeting on Budgeting under NATP Programme at PD CSR Modipuram	Modipuram(Meerut) Nov 30 1st Dec 1996	Participation

Training/deputation/visits of staff members during 1996 97 (International)

Name of the official	Subject	Duration	Place	Outcome of Visit
M S Ramesha	i) Use of AFLP in in rice improvement	28 days (26 11 96 to 20 12 96)	IRRI Philippines	Trained in AFLP techniques
	Cytoplasmic diversification by protoplast fusion Technology	3 weeks 8 29 March 97	University of Nottingham UK	Trained in protoplast fusion technology in rice
S M Balachandran (Scientist Biotechnology)	Group Training Course in Gene Manipulation for Agriculture	10 Sept 29 Oct 1996	Faculty of Agriculture The Hebrew University of Jerusalem Rehovot Israel	Trining in molecular techniques and genetic manipuation
Dr R M Kumar	Rice Cultivation Technology	10th Feb to 8th Nov 1996	Tsukuba Japan	Exposure to latest rice production Technology

Deputation/Visits abroad

K Krishnaiah	Tech Evaluation & impact for sustainable sustainable rice production	Oct 29 31 96	Bangkok Thailand	Expert consultation
	Development of Hybrid Rice	Dec 9 25 96	Beijing China	Study Tour
	IRRC and IPM Network	March 17 20	Philippines	Inaugural/Steering Committee Meeting
B C Viraktamath	Project Scientist (Hybrid Rice)	18 months Dec 1995	IRRI Philippoines	
Dr N P Sharma	Asian Rice Biotechnology Network(ARBN) 1 Planning Workshop	6 10 May 96	International Rice Research Institute	Programme planning of ARBN Project
Dr S V Subbaiah	International Workshop on Natural Research Managementin Rice system Technology Adaptation for efficient Nutrient Use	2 5 Dec 1996	Bogor Indonesia	Presented a paper
C Kesava Reddy	Plant Physiology	7 months (Jan Aug 96)	IRRI Philippines	Some experiments on nutrient use efficiency were conducted
Dr A PK Reddy Dr K Satyanarayna	International Workshop on rice disease manage ment technology	11 13 June 96	Sengai Petani Malaysia	Present Paper
I C Pasalu	Workshop on gallmidge management	28 30 Oct 1996	Lao PDR	Presented a paper

VISITORS

Distinguished visitors during 1996-97

Name of visitor	Affiliation	Purpose of the visit
Dr S S Virmani	Plant Breeder cum Deputy Head IRRI Philippines	Consultant for the Hybrid Rice Project
Dr James R McWilliams	International Agil Consultant	For mid term evaluation
Dr Hiroshi Ikehashi	Prof of Plant Breeding Kyoto University Japan	of the project
Dr D N Jha	Director NCAEPR New Delhi	do
Dr W H Freeman	International Agril Consultant	To see the hybrid rice programme
Dr M Balasubramanian	World Bank New Delhi	Visit to Hybrid rice
Dr R U Chowdhary	Project Coordinator (NSP)	Visit to Hybrid rice
Mr Shashikanth Suthar	Min (Agri & Irrigation) Govt of Maharashtra Mumbai	General Visit
Dr Santiago R Obien	Director Philippine Rice Research Institute Philippines	General Institute Visit
Dr Sanjay Duba	Farming Systems Agronomist Min of Agriculture Bhutan	General Institute Visit
Dr Mandungu Bula Nyati	Embassy of Zaire	General Institute Visit
Dr Kitenge Nkumbi Kasra	Embassy of Zaire	General Institute Visit
Dr Rahimov PN	Director USNIIT Uzbekistan	General Institute Visit
Dr Vibha Pandey	Director (F) ICAR	General Institute Visit
Dr D K Tiwari IAS	Project Director Bihar Plateau Development Project Ranchi	General Institute Visit
Dr Darren Phillips	FAO Consultant (Australia/ Tasmania)	General Institute Visit
Dr Tim C B	Chancellor (NRI IRRI Vector Ecologist)	Visit to Entomology Dept on IPM related work
Dr N W Blackhall	Experimental Officer Plant Genetic Manipulation Group University of Nottingham UK	Visit to Entomology Dept on IPM related work
Dr Dayachari	Managing Director APDDCFL Hyderabad	General Institute Visit
Dr M A Hamid Miah	Member Director (Crops) Bangladesh	General Institute Visit
Dr Abdur Rauf	Minister of State Agriculture Assam	General Institute Visit
Dr Simon Eden G	NRI Chattam UK	IPM/Pheromone programmes appraisal
Dr Alan Cork	NRI Chattam UK	IPM/Pheromone programmes appraisal

Fig 22 a Dr R S Paroda Director General visiting DRR and reviewing research activities of DRR

Fig 22 b Dr Mangala Rai Deputy Director General (Crops) visiting DRR laboratories and discussing research programmes

TECHNICAL PROGRAMME

On-going Research Programme of the Institute, 1996-97

Institute Code	Project Title	Year of Start	Likely Year of completion	Project Leader/ Associate(s)
Br 1	Genetic enhancement of rice varieties with multiple resistance to existing and emerging major pests and diseases	1990	1998	U Prasada Rao/ I C Pasalu K Krishnaiah A PK Reddy N P Sarma
1 1	Evolution of varieties with resistance to BPH RTV and Blast to suit *Kharif* season			U Prasada Rao A PK Reddy / N V Krishnaiah G S V Prasad
1 2	Breeding varieties with durable resistance to blast resistance			G Padmavathi/ K Satyanarayana U Prasada Rao
1 3	Genetic characterisation of host plant resistance to rice gallmidge	1995	1998	U Prasada Rao/ I C Pasalu J S Bentur
Br 2	Development and Evaluation of hybrids in National Hybrid Rice Trials	1989	Continuing	M Ilyas Ahmed / B C Viraktamath C H M Vijaya Kumar M S Ramesha
2 1	Development of use of environmentally sensitive genic male sterility (EGMS) for exploitation of heterosis	1993	2000	M Ilyas Ahmed / B C Viraktamath C H M Vijaya Kumar M S Ramesha
2 2	Genetic enhancement of heterosis	1994	1997	C H M Vijaya Kumar/ M Ilyas Ahmed B C Viraktamath M S Ramesha
2 3	Development of inter subspecific hybrids	1994	1999	C H M Vijaya Kumar/ M Ilyas Ahmed B C Viraktamath M S Ramesha
2 4	Diversification of CMS sources in Rice	1993	2000	M S Ramesha/M Ilyas Ahmed B C Viraktamath S M Balachandran

Institute Code	Project Title	Year of Start	Likely Year of completion	Project Leader/ Associate(s)
2 5	Improvement of parental lines in rice	1993	2000	M S Ramesha/ B C Viraktamath M Ilyas Ahmed C H M Vijaya Kumar
Br 3	Genetic enhancement of quality rices for higher productivity and export (an ICAR network programme)	1994	1997	N Shobha Rani
Br 4	Biotechnology for genetic enhancement of rice	1993	2000	N P Sarma/S M Balachandran Arti Pothukuchy
Br 5	Breeding rice varieties for abiotic stress (a) Saline/alkaline conditions (b) Deficiency for Zinc K P soil status	1993	1998	T Ram/M N Reddy S Balachandran
Br 6	Breeding for new plant type to break the yield barriers in rice	1993	2000	S K Agarwal/T Ram N D Majumder L V Subba Rao
Br 7	Maintenance and evaluation of germplasm	1995	2000	N D Mazumdar T Ram/ U Prasada Rao G S V Prasad
Br 8	Seed production and seed technology	1993	2000	L V Subba Rao/S K Agarwal
8 1	Maintenance of nucleus seed and breeder seed production of rice varieties as per the indent of GOI	1995	Continuing	L V Subba Rao/U Prasada Rao
Br 9 Rani	All India Co ordinated rice improvement project	Continuous		U Prasada Rao/ N Shobha N D Mazumder T Ram S K Agarwal L V Subba Rao G Padmavathi G S V Prasad
Ent 1	Host plant resistance to major insect pests	1993	1998	I C Pasalu/ K Krishnaiah J S Bentur N V Krishnaiah
Ent 2	Chemical control of rice insects pests	1994	1999	N V Krishnaiah/I C Pasalu K Krishnaiah
Ent 3	Biorational (Biological) control methods	1995	1998	K Krishnaiah/G R Katti J S Bentur

Institute Code	Project Title	Year of Start	Likely Year of completion	Project Leader/ Associate(s)
3 1	Role of phe omones in IPM	1994	1999	K Krishnaiah/I C Pasalu
3 2	Kairomones and synomones in IPM	1996	2000	V Jhansi Lakshmi/ K Krishnaiah
Ent 4	Ecological and Biological studies on rice pests	1995	1999	I C Pasalu/J S Bentur
Ent 5	Studies on the parasitic nematode problems of rice and rice based cropping systems	1995	1999	J S Prasad/ K S Varaprasad (NBPGR)
PP 1	Evaluation of rice germplasm to biotic stresses	1993	1997	A PK Reddy/ K Satyanarayana
PP 1 2	Evaluation of host plant resistance to sheath blight	1993	Continuing	C S Reddy
PP 2	Pathogenic variability of major rice pathogens	1993	1997	A PK Reddy/ K Satyanaryana
PP 2 1	Studies on pathogenic variability and acquired host resistance to sheath blight	1993	1998	C S Reddy
PP 3	Ecology and epidemiology Developing prediction models for insect pests	1993	1997	K Muralidharan
PP 3 1	Biology of sheath rot disease to understand the etiology of the disease	1994	1998	S Venkataraman/ G S Laha
PP 4	Disease Management Biological control of rice pathogens	1994	1998	S Venkataraman/ G S Laha
PP 4 1	Studies on fungicides in the control of sheath blight	1993	Cont	C S Reddy
PP 4 2	Blast disease management Evaluation of synergism between host resistance and fungicides	1993	1999	K Satyanaryana
PP 5	Co ordinated Pathology programme	1969	Continuing	A PK Reddy S Venkataraman K Satyanarayana C S Reddy

Institute Code	Project Title	Year of Start	Likely Year of completion	Project Leader/ Associate(s)
Ag 1	Developing efficient N management in low land rice ecosystems adopting chlorophyll meter and leaf color techniques (DRR IRRI CREMNET Project)	1996	1998	S V Subbaiah/S P Singh Raghuveer Rao K Rama Rao & Mahendra Kumar Sri K Rama Rao and Mr I S R P Sarma
Ag 2	Studies on complementary use of granulated inorganic fertilisers in conjunction with organic manures for sustainable rice production	1995	1998	S V Subbaiah/ R Mahendra Kumar Surekha
Ag 3	Studies on utilisation of indigenous phosphate rock and sources for increasing fertilizer phosphorus utilisation and P use efficiency of rice	1994	1998	S V Subbaiah/ R Mahendra Kumar S P Singh B Sreedevi
Ag 4	Crop weed completion & weed management practices under different systems of rice cultures	1993	1998	B Sreedevi/S P Singh S V Subbaiah
Ag 5	Agronomic packages for basmati rice	1993	1997	S PSingh/B Sreedevi S V Subbaiah N Shobha Rani
Ag 6	Development of agronomic package for hybrid rice & their parents	1995	1998	S P Singh/ R Mahendra Kumar S V Subbaiah
Ag 7	Influence of nursery management dynamics on the yield potential of rice	1995	1998	B Sreedevi R M Kumar S V Subbaiah
Ag 8	Production potential of rice based cropping system	1995	1998	R M Kumar/B Sreedevi S V Subbaiah S P Singh
SS 1	Nutrient Management for sustainable Rice based cropping systems	1993	1997	M Narayana Reddy/ K Surekha
SS 2	Nutrient Dynamics and its Management for improved use efficiency in irrigated rice	1993	1999	K V Rao/D K Kundu S P Singh K Surekha

Institute Code	Project Title	Year of Start	Likely Year of completion	Project Leader/ Associate(s)
SS 3	Efficient use of soil and applied nutrients in lowland rice of native soil N in wetland rice	1995	1999	D K Kundu/K V Rao T Ram
3 1	Nutrient requirement for sustaining rice yield in intensively cultivated lowland (Long term experiment)	1990	2000	D K Kundu/K V Rao K Surekha K G Pillai
SS 4	Studies on Potassium Nutrition in Hybrid Rice vs conventional HYV s	1996	1998	K Surekha/M N Reddy V Balasubramanian R M Kumar V Jhansilakshmi
PHY 1	Physiological studies on rice hybrids	1995	2000	V Balasubramanian/ M Ilyas Ahmed
PHY 2	Genotype Environmental interaction	1995	1998	C Kesava Reddy
Ag Engg 1	Evaluation of different paddy seeders and planters	1995	1998	K Rama Rao/ISRP Sarma
Ag Engg 2	Evaluation of rice mill for different paddy varieties	1995	1998	K Rama Rao/ISRP Sarma
Ag Stat 1	Growth performance of Indian rice sector Cross State Analysis	1996	1997	A V Rao/A Janaiah AS Rama Prasad
Ag Stat 2	Reduction in the response of N P and K fertilization	1996	1997	A V Rao A S R Prasad/ A Janaiah
Ag Econ 1	The comparative economics and adoption behaviour of Hybrid Rice Technology in India	1996	1998	A Janaiah/B S N Reddy A S R Prasad
Ag Econ 2	Impact of farm mechanization on sustainable livelihood of the rice farming households A comparative assessment	1996	1998	A Janaiah
CTC 1	Impact of short term DRR training programmes on improved rice technologies	1994	1997	Mahabir Singh/Mangal Sain
CTC 2	Training Needs Assessment in Rice	1995	1999	B S N Reddy/PS Doijad

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7 Progress Report *Rabi* 1996 DRR P 69

8 Production Oriented Survey 1996 DRR P 44

LIST OF STAFF MEMBERS

S No	Name of the official	Designation
1	Dr K Krishnaiah	Project Director
PLANT BREEDING		
1	Dr U Prasada Rao	Senior Scientist & Incharge Head
2	Dr N Shobha Rani	Senior Scientist
3	Dr N D Mazumdar	Senior Scientist
4	Dr T Ram	Scientist (Sr Scale)
5	Dr Shivkumar Agarwal	Scientist (Sr Scale)
6	Dr L V Subba Rao	Scientist (Sr Scale)
7	Ms G Padmavathi	Scientist
8	Dr G S V Prasad	Technical Officer (T 5)
9	Mr B Shivakumar	Technical Assistant (T 4)
10	Mr P Devendar	Field Technician (T II 3)
11	Mr Prakash Ganwar	Field Technician(T II 3)
12	Mr P Ramu	Technical Assistant (T II 3)
13	Mr T L Acharyulu	Technical Assistant(T II 3)
14	Mr P Adisesha Rao	Field Technician (T I 3)
15	M Vijaya Kumar	Field Technician (T II 3)
16	Mr P Vittalaiah	Field Technician (T 2)
17	Mr E Nagarjuna	Field Technician (T 2)
18	Mr Mohd Tahseen	Field Technician (T 2)
19	Mr C Muralidhar Reddy	Field Technician (T 1)
20	Mr M Devaiah	Field Technician (T I)
21	Mr A Venkataiah	Field Technician (T 1)
22	Mr V Chiranjivi	Sr Stenographer
23	Mr V Sridhar	Jr Clerk
BIOTECHNOLOGY		
1	Dr N P Sarma	Principal Scientist & Head
2	Mr S M Balachandran	Scientist(Sr Scale)
3	Dr Arti Pothukuchy	Scientist
HYBRID RICE		
1	Dr Ilyas Ahmed	Senior Scientist
2	Dr B C Viraktamath	Senior Scientist
3	Dr M S Ramesha	Scientist
4	Dr CHM Vijay Kumar	Scientist
5	Mr T Prabhakar Rao	Stenographer
6	Mr Mohd Sadath Ali	Field Technician (T 1)

S No	Name of the official	Designation
PLANT PHYSIOLOGY		
1	Dr V Balasubramanian	Principal Scientist & Head
2	Dr C Kesava Reddy	Senior Scientist
3	Dr S Padmaja Rao	Senior Scientist
4	Dr P Raghuveer Rao	Scientist
5	Mr S Prabhakar	Senior Clerk
6	Mr G V S Sivaprasad	Field Technician (T I 3)
7	Mr K Ramulu	Field Technician (T 2)
AGRONOMY		
1	Dr K G Pillai	Principal Scientist & Head*
2	Dr S V Subbaiah	Principal Scientist &Head
3	Dr S P Singh	Senior Scientist
4	Dr P Krishna Murthy	Senior Scientist
5	Dr R Mahender Kumar	Scientist
6	Ms B Sreedevi	Scientist
7	Mr A Prem Kumar	Junior Stenographer
8	Mr S Nagaiah	Field Technician (T I 3)
9	Mr D J Samraj	Field Technician (T I 3)
10	Mr Ch Sivannarayana	Field Technician (T I 3)
11	Mr B P Anjaneyulu	Field Technicianm(T 2)
SOIL SCIENCE		
1	Dr M Narayana Reddy	Senior Scientist & I/C Head
2	Dr K Vedavyasa Rao	Senior Scientist
3	Dr D K Kundu	Scientist (Sr Scale)
4	Dr K Surekha	Scientist
5	Mr K Mallikarjunudu	Junior Clerk
6	Mr G Gandhi	Technical Assistant (T II 3)
7	Mr T Jagannadha Rao	Field Technician (T 2)
8	Mr A Narsing Rao	Field Technician (T 2)
9	Mr K Ramchander	Field Technician (T II 3)
10	Mr U Puallaih	Field Technician (T II 3)
AGRICULTURAL ENGINEERING & WORKSHOP		
1	Mr K Rama Rao	Principal Scientist & Head
2	Mr G R Ramakrishna Murthy	Scientist*+
3	Mr I S R P Sarma	Scientist
4	Mr M Krishna Reddy	Mechanic (T I 3)
5	Mr S Subramaniam	Mechanic (T I 3)
6	Mr S Venkatachalam	Electrician (T I 3)
7	Mr T Narender Pershad	Plumber

S No	Name of the official	Designation
8	Mr Sarwandas	Driver
9	Mr Osman Khan	Driver
10	Mr K Pandu	Driver
11	Mr Sharifuddin	Driver
12	Mr PGovindaraj	Driver
13	Mr V Srinivasa Rao	Driver
14	Mr Ch Nagabushanam	Driver
15	Mr G Thirupathaiah	Driver
16	Mr K Narsimha	Driver
17	Mr K Janardhan	Driver
AGRICULTURAL ENTOMOLOGY		
1	Dr I C Pasalu	Principal Scientist & Head
2	Dr N V Krishnaiah	Senior Scientist
3	Dr J S Bentur	Senior Scientist*
4	Dr J S Prasad	Senior Scientist
5	Dr PR Srinivas	Scientist (Sr Scale)
6	Dr G R Katti	Scientist (Sr Scale)
7	Ms V Jhansi Lakshmi	Scientist
8	Ms Aparna Das	Junior Stenographer
9	Mr Y Kondala Rao	Technical Officer (T 5)
10	Mr Amudhan	Field Technician (T II 3)
11	Mr G Rama Rao	Field Technician (T I 3)
12	Mr Y Sambasiva Rao	Field Technician (T I 3)
13	Mr T Venkaiah	Field Technician (T 1)
PLANT PATHOLOGY		
1	Dr A PK Reddy	Principal Scientist & Head
2	Dr K Muralidharan	Principal Scientist
3	Dr S Venkataraman	Principal Scientist
4	Dr K Satyanarayana	Senior Scientist
5	Dr C Sadasiva Reddy	Senior Scientist
6	Dr P Chakrapani Reddy	Senior Scientist@
7	Ms D Krishnaveni	Scientist*+
8	Dr G S Laha	Scientist
9	Mr B Ramesh	Junior Stenographer
10	Mr B Narsimha Reddy	Field Technician (T II 3)
11	Mr Thakur Basant Singh	Field Technician (T I 3)
12	Mr P Sankaranarayana	Field Technician (T I 3)
13	Mr Ch Anantha Reddy	Field Technician (T 1)
AGRICULTURAL STATISTICS & ECONOMICS		
1	Mr A V Rao	Principal Scientist & Head
2	Dr C Subba Rao	Senior Scientist
3	Dr A Janaiah	Scientist
4	Dr G P Reddy	Scientist
5	Mr A S Rama Prasad	Technical Officer (T 5)

S No	Name of the official	Designation
COMMUNICATION AND TRAINING CENTRE		
1	Dr Mahabir Singh	Principal Scientist & Head
2	Dr Mangal Sain	Sr Scientist(Entomology)
3	Dr B S N Reddy	Scientist (Sr Scale)
4	Mr PMuthuraman	Scientist* *
5	Dr PS Doijad	Communication Specialist (T 7)
6	Mr K Devadasu	Senior Stenographer
7	Mr D Gandhi	Computor (T II 3)
8	Mr D Digambar	Audio Visual Operator (T-I 3)
9	Mr D S Vinod Kumar	Senior Artist (T-4)
10	Mr Ch Sadanandam	Videographer (T-II-3)
11	Mr K Chaitanya	Senior Photographer (T-II 3)
AGRICULTURAL CHEMISTRY		
1	Dr A G K Murthy	Sr Scientist
ADMINISTRATION & ACCOUNTS		
1	Mr S Veeraswamy	Administrative Officer#
2	Mr PJanakirama Sarma	Asst Finance & Accounts Officer
3	Mr K Satyananda Rao	Asst Admn Officer
4	Mr T V Varghese	Senior Stenographer
5	Ms Judith Daniel	Stenographer
6	Mr G Krishna	Superintendent (C&B)
7	Mr A Narasimha Murthy	Superintendent (A&A)
8	Mr Ch Seshu Babu	Superintendent (Estt)
9	Mr S Rengarajan	Assistant
10	Mr PNarender	Assistant
11	Mr K Satya Priya	Assistant
12	Mr K Kumaraswamy	Assistant
13	Mr S Narsing Rao	Assistant
14	Ms P Laxmi	Sr Clerk
15	Mr R Uday Kumar	Stenographer
16	Mrs K Kausalya	Senior Clerk
17	Ms T D Pushpalatha	Senioi Clerk
18	Ms K Sudha Valli Tayaru	Senioi Clerk
19	Ms U Rama	Senior Clerk
20	Ms Sudha Nair	Junior Clerk
21	Ms M Kamala	Junior Clerk
22	Mr Ahmed Hussain, S K	Junior Clerk
23	Ms Vanita	Hindi Typist
LIBRARY		
1	Mr PVenkataramana	Technical Officer (T 5) #
2	Mr B Vidyanath	Junior Clerk

* on deputation ** on study leave @ on leave # transferred

ADMINISTRATION AND FINANCE

BUDGET ALLOCATION DURING 1996-97 WITH ACTUAL EXPENDITURE

(in lakhs)

	Plan		Non-Plan	
	**Amount sanctioned	Amount spent	Amount sanctioned	Amount spent
DRR Headquarters }}	415 00	163 45	168 00	168 00
DRR centres }}		251 55		

**Combined for DRR headquarters and centres

CADRE STRENGTH OF SCIENTIST TECHNICAL ADMINISTRATION & SS GRADES AT DRR AS ON 31 3 1997

S No	Cadre	Sanctioned	Filled	Vacant
1	Scientists	61	58	3
2	Administration	36	35	1
3	Technical	61	61	-
4	Supporting Grades	61	61	-
	TOTAL	**219**	**215**	**4**

ACKNOWLEDGEMENT

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DIRECTORATE OF RICE RESEARCH

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

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चावल अनुसंधान निदेशालय

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