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SUMMARY OF RESULTS FOR - 1967

IRAN AND INDIA

IRAN

GENERAL:

A two-day work planning meeting was held in January 1967 at Karaj, attended by U.S. and Iranian project technicians, Karaj College and Ministry of Agriculture staff, Cooperators from Pahlavi University in Shiraz and the Ghazvin Development Project (cooperative program between Iran and Israel). In this meeting the 1967 program was formulated.

A workshop was held July 17-20, 1967; attended by delegates from Turkey and India. Delegates from Pakistan and other countries were unable to attend because of visa and passport difficulties.

From the large germplasm collections in India and Iran seed materials have been sent to or exchanged with Nigeria, Rhodesia, U.A.R., Turkey, Lebanon, Jordan, Pakistan, Thailand, Vietnam, Malaysia, Japan, the Philippines, Dominican Republic and Chile.

Discussions were held with Ministry of Agriculture and Plan Organization officials to obtain greater participation - both technical and financial - from the Government of Iran in the pulse crop work. As a result Iran, with the start of its next five-year plan in March 1968 has agreed to contribute 10 million rials per year ($133,000). This will handle essentially all local support costs for the RPIP operations at Karaj and Ministry of Agriculture work at several stations throughout Iran. This is in addition to the greenhouse - laboratory building already constructed at Karaj and contributions of facilities and services made by other institutions including Pahlavi University, Gazvin Development Project and Dez Irrigation Project.

Investigations conducted between 1964 and 1967 supplied information on

(1) growth characteristics of local and introduced types of five major pulse crops - beans, mungbeans, cowpeas, chickpeas and lentils.

(2) identification and control of diseases and insects and (3) soil and crop management practices to increase crop yields.

The end of the 1967 crop season saw the following specific accomplishments:

BREEDING:

Several strains were outstanding in yield tests and have been recommended to the Ministry of Agriculture for seed increase and release. These are:

(1) White bean strain No. 49, originating in Shiraz area. It has yielded an average of 15% more than other varieties in tests at 7 locations over 3 years.

(2) Red bean strain No. 50 originating in Esfahan area, with an average of 20% greater yield.

(3) Pinto bean strain No. 446 (Accession 65-071-00446). It originated from Esfahan, yields equal to U.S. pinto varieties but has a more acceptable seed type for the local market.

(4) Chickpea strains No. 416 M and 438M with yield advantages of 9% over the average of other varieties in the same tests.

(5) Cowpea strains No. 50 and No. 4002. Strain No. 50 originated in Turkey. Strain No. 4002 was collected in the Meshed area of Iran but is unlike the indigenous material and so similar to some of the U.S. cowpea varieties

like Blackeye No. 7 that the question of its real origin arises.

SOIL AND CROP MANAGEMENT:

Improved cultural practices such as correct planting date, seeding rates, fertilization and irrigation have been shown to improve yields as much as 300 to 400% over those presently obtained by farmers.

Planting data experiments have shown the correct date of planting for all major pulse crops.

Sufficient seed should be planted to obtain 300,000 to 400,000 plants per hectare.

Maximum yields depend on adequate levels of both moisture and fertility. Chickpea yields were increased by 1.98 tons per hectare or 14% as a result of fertilization and irrigation. Lower increases were obtained if either fertilization or moisture was lacking. Similar results were found in cowpeas and dry beans.

Phosphorus fertilization responses were found when phosphorus content of soil was 2-3 ppm. or less. Yields were not increased by nitrogen fertilization.

Fungal diseases in lentils were found to be more serious under high moisture as a result of frequent irrigations. High fertility had this effect also.

PATHOLOGY:

Bean common mosaic virus (BCMV) reduces yield up to 68%. It was found to be seed transmitted through more than 50% of the seed of many varieties. Out of 1952 bean lines in the nursery 29 showed at least some resistance.

Bean yellow mosaic virus (BYMV) damages broadbeans and chickpeas most years. Seed transmission is very slight in both crops but mechanical and aphid transmission are rapid. Yield reductions were found as high as 75-90%.

Alfalfa mosaic virus attacks chickpeas, reducing yields of infected plants from 72 to 96% No resistance has as yet been found.

Cowpea aphid-borne mosaic virus (CAMV) is widespread and severely damaging to cowpeas, reducing yields as much as 80%. Six varieties out of 54 tested showed resistance.

Pathogens associated with various root-rot diseases were isolated and identified.

Several other viruses as well as fungal diseases are being studied.

ENTOMOLOGY:

Although 1967 trials in general were very inconclusive because of low insect infestations on the basis of 3 years work the following recommendations have been made.

(1) Bean butterfly (Lycaena baeticae) - Crop: Cowpea.

Recommendations: DDT and Toxaphene, Diazinon, Dimethoate, Dylox, and Malathion.

(2) Jassids (Eposasca sp.) - Crop : all pulses.

Recommendations: Diazinon, Sevin, Carbophenothion, Malathion, Ethion, and Dimethoate.

(3) Mites (Tetranychus bimaculatus) - Crop : dry beans and mungbeans.

Recommendations: Tedion, Kelthane, and Ethion.

(4) Seed corn maggot (Hylemya cilicrura) - Crop : dry beans.

Recommendations: no insecticide, but minimum damage if crop planted after soil temperature at planting depth reaches 18°C.

(5) Cotton bollworm (Heliothis zea) - Crop : chickpeas

Recommendations: DDT - Lindane, Sevin.

Work was continued on control of pests of stored seed (primarily Bruchus sp.). After some setbacks in the investigations with the chemicals Bromodan and Alodan (Hoechst Chemical Company), results have again been encouraging. After further work both in Iran and in India a final report and regional recommendation will probably be made in 1968.

Evaluation for possible genetic resistance to the major insect pests was started but did not yield any conclusive results.

Preliminary irradiation trials indicated that sterility can be induced in the adults, pupae, and larvae of beet armyworm (Spodoptera exigua). This work is continuing.

Results of chemosterilant work have not been encouraging.

Studies on nematodes conducted in cooperation with the Ministry of Agriculture, Plant Pest Control Institute showed degrees of resistance to Malloidegyre nemotodes among 10 varieties of mungbeans. However field and greenhouse trials did not agree sufficiently to make the results conclusive

PLANT BREEDING

K.H. Evans, Plant Breeder
Counterparts: Jamshid Jafari
Mehdi Khosroshahin, Ali Ellini
Mohammad Moadab, Ahmad Sarafi
(Karaj College)

Lentils

Small seeded root rot resistant strains of lentils from Esfahan and Fars produce yields approximately double those of large seeded types in the absence of root rot symptoms. The yield difference is larger when root rot is severe. Some strains could be recommended for increase and release, but the market value of small seeded types is very low.

A preliminary market survey indicates small seeded types bring 6 to 8 rials per kilo while large seeded types range from 12 to 27 rials per kilo, the higher prices being paid for uniformly large greenish lentils.

Chickpeas

A preliminary market survey indicates that large white seeded chickpeas are much preferred for cooking over wrinkled, dark or small seeded types. The high yielding strains of chickpeas from our collection are the less desirable seed types. Before recommending a white chickpea strain for increase and release, more market evaluation or breeding is necessary.

Black chickpeas are used as split peas. There is little range in their price. Two black chickpea strains (416 M and 438 M) with yield advantages of 9% over the average of other better strains are being recommended for increase and release.

Beans

The three main types of beans used in Iran are red, cranberry pinto, and white. A preliminary market survey indicates large seeded varieties are more

expensive than small seeded types. Red and pinto beans are more expensive than white varieties.

Three bean varieties are being recommended for seed increase and release. Strain number 49 from Shiraz with a 15% yield advantage over the average of better selections available is being recommended as a white bean variety. Strain number 50 from Esfahan with a 20% yield advantage over the average of better red bean strains is being recommended as a red bean variety, accession number 65-071-00446 with yields equal to U.S. Pinto varieties, but more acceptable seed type, is being recommended as a pinto variety. These three bean strains show little or no virus symptoms in the field. Greenhouse inoculation tests are being conducted.

Mungbeans

On the basis of three years data, two mungbean varieties are being recommended for increase and release. Strain No. 3 (U.S. Department of Agriculture PI No. 31287, Beltsville) with an average yield advantage of 20% over the Iranian check strain is being recommended for increase and release. Strain number 72 (PI 183130) with less yield advantage, but larger seed which has a higher market value is also being recommended for increase and release. Both of these strains have shown field disease resistance.

Cowpeas

Two strains of cowpeas (50 and Mashad selection) are being recommended for increase and release. These two strains appear tolerant of the most severe virus disease. These two strains do not yield as much as some U.S. blackeyes in test plots where disease transmitting insects are controlled, but will yield considerably more than U.S. Blackeyes where disease is prevalent.

SOIL AND CROP MANAGEMENT

G. M. Horner - Soil Scientist
Counterpart: M. Mojtehedi

Date of Planting - The optimum planting date depended on the crop and the location. Lentils planted in the fall survived through the winter at Karaj, but grain yields were less than for early March plantings. Serious winter injury occurred in Karaj on chickpeas planted in the fall. However, lentils and chickpeas both grew well when fall planted at Varamin, an area with milder weather conditions. Maximum yields of dry beans, cowpeas, and mungbeans were obtained from plantings made during the first half of May at Karaj.

Plant Population and Row Spacing. Yields of chickpeas, cowpeas, and dry beans increased with a reduction in row spacing. This trend held for all spacings tested ranging from 40 to 70 cm. Confirming 1966 results, seed yields of each crop increased with an increase in plant density up to 300,000 plants per hectare.

Herbicides - Of the four herbicides tested, Lorox was more satisfactory than Treflan, Eptam, or Dacthal for weed control, lack of injury to pulse crops, and ease of application under the operating conditions of the Project's field plots. Dry beans showed good resistance to injury caused by the four herbicides. Lentils and mungbeans were damaged by high rates of Treflan.

Irrigation and Disease - Maintaining high soil moisture by frequent irrigations (at 6-day intervals) increased the occurrence of fungal diseases in lentils. Grain yields were greatly reduced, especially for susceptible varieties at high fertility levels.

Irrigation and Fertilization - Yields of chickpeas, cowpeas, and dry beans were increased by irrigating so as to maintain available soil moisture above two-thirds of field capacity during bloom and early maturity stages of growth. Allowing soil moisture to approach the wilting point during this period decreased yields. A strong response to phosphorus fertilization occurred where the available phosphorus content of the soil was 2-3 p.p.m. or less. Yields were not increased significantly by nitrogen fertilizer.

Maximum yields depended on adequate levels of both moisture and fertility. For chickpeas at a low fertility level, adequate moisture increased grain yield by 0.48 ton per hectare. But at high fertility, the same irrigation treatment increased yield by 1.34 tons. Similarly, fertilization increased yields by 0.46 ton and 1.50 tons, respectively, under low and high soil moisture levels. The combination of adequate levels of both moisture and fertility increased chickpea yield by 1.98 tons or 140% above that for low soil moisture and no fertilization. Results for cowpeas and dry beans followed a similar pattern, altho the yield increases were smaller.

PLANT PATHOLOGY

Walter J. Kaiser - Pathologist
Counterparts: Dariush Danesh
Mahmoud Okhovat
Hossein Mossahebi

Bean common mosaic virus (BCMV) which is the most widespread and important disease of beans in Iran is transmitted through more than 50% of the seed of many bean varieties tested in Iran. Yield reductions of up to 68% were observed in bean varieties infected with BCMV. Plants infected with BCMV were found in all but 1.5% of 1952 bean lines grown in RPIP observation trials at Karaj College.

No resistance to bean yellow mosaic virus (BYMV) was observed in 85 broadbean strains grown in observation trials in Khuzestan. This mechanically transmitted virus was found to be seed-borne and aphid transmitted. In 20 strains comprising over 19,000 plants there was only 0.2% seed transmission of BYMV. However, by maturity this virus had spread to more than 85% of the plants. A newly discovered aphid-transmitted virus disease, variously known as broadbean yellows, bean leaf roll, pea leaf roll or pea top yellows, was present in 85% of the broadbean strains included in the Khuzestan trial. Infected plants are chlorotic, stunted and sterile. Pea leaf roll virus is not confined to broadbeans, but has been observed in peas and beans, and possibly other pulse crops, including chickpeas and cowpeas.

In Iran chickpeas are naturally infected by three viruses - alfalfa mosaic (AMV), bean yellow mosaic (BYMV), and cucumber mosaic (CMV). All three chickpea viruses are mechanically and aphid transmitted, but apparently

not seed-borne. In field inoculation studies seed yields were reduced 72-96% with AMV, 77-92% with BYMV, and 52% with CMV. In a planting of six black and white chickpea lines 5-13% of the plants were naturally infected with BYMV. Seed yields from these virus infected plants were decreased an average of 98%. Greenhouse tests have proved the pathogenicity of Rhizoctonia solani, Macrophomina solani, Pythium ultimum and Fusarium solani to the roots of chickpea. At times root rot causes serious damage to chickpeas grown in various areas of Iran.

A seed-borne, aphid transmitted virus-tentatively identified as cowpea aphid-borne mosaic virus (CAMV) -- is the most important and widely distributed disease of cowpeas. Greenhouse and field inoculations with this virus decreased seed yields up to 80%. Seed transmission in 26 lines varied from 0 to 30+%, and yields from infected plants were decreased from 13-83%. In greenhouse inoculation studies 6 lines out of 54 tested were resistant to CAMV. Alfalfa mosaic virus, which is potentially an important disease when cowpeas are grown adjacent to virus-infected alfalfa, reduced cowpea seed yields in greenhouse and field tests 17 to 76%. This aphid-transmitted virus is apparently not seed-borne in cowpeas. In greenhouse inoculations none of the 54 cowpea lines showed any resistance to AMV.

One of the most economically important diseases of mungbean is an aphid-transmitted, seed-borne virus called mungbean mosaic virus (MMV).

This virus, which is a flexuous rod 750 mμ in length, appears to be a strain of bean common mosaic virus. In field tests seed transmission in 13 mungbean strains ranged from 0 to 25+%. Seed yields from virus infected plants were decreased up to 75%. A crown rot disease of mungbeans caused by Rhizoctonia solani was responsible for 4 to 57% mortality in young plantings of the crop. Greenhouse tests revealed large differences in pathogenicity of Rhizoctonia isolates to mungbean. Sampling of field soil showed Rhizoctonia to be confined to the top 20 cm which is the zone of most abundant root development.

ENTOMOLOGY

Shannon W. Wilson - Entomologist
Counterparts: K. Kamali
G. R. Rassowlian

Pest activity on pulse crops in the Karaj and Varamin area was extremely limited in 1967. Only trace infestations of pulse pests were observed with the following exceptions; Leaf miner *Liriomyza congesta*, seed corn maggot *Hylemya cilicrura*, and mites *Tetranychus bimaculatus*.

Leaf miner *L. congesta* was first observed in Karaj on chickpeas May 31, 1967. The infestation was quite severe with 64% of the leaves showing damage. All RPIP chickpea plots in Karaj were sprayed with *diazinon* at a rate of *1 kg. actual ha.*, except for the entomology plots. Control results were good.

A trial was conducted on the entomology chickpeas for the purpose of determining the most effective chemical control. However, an undetermined disease destroyed 90% of the entomology chickpea plots. Due to the heavy loss to the entomology chickpeas, no results were obtained.

In anticipation of seed corn maggot *H. cilicrura* infestations, a seed treatment trial was conducted on dry beans. Seeds were treated with slurries of diazinon, dieldrin, dimethoate, and lindane.

Optimum weather conditions resulted in a rapid plant emergence; and although some plots had over a 90% infestation, plant damage was minimal. The low plant loss made the results invalid. Foliar spray trials were conducted on mite infestations of the *T. bimaculatus* complex. Dry beans were sprayed with a single application as shown in Table I.

TABLE I

Miticides	Population*		
	1 day before spraying	3 days after spraying	10 days after spraying
Tedion 1 kg/Ha.	901	109*	157*
Kelthane 600 gm/Ha.	617	125*	105*
Ethion	778	[illegible]*	57*
Erysit 300 gm/Ha.	889	260	380
Check	807	286	434

* S.D. at 1% level

The mite infestation was moderate and occurred too late to have any significant effect on seed yield.

Pesticide trials were conducted on the following insects, but infestations did not develop;

Cowpeas - Spittle bug (Varamin and Karaj)
Cowpea weevil (Varamin)

Lentils - lentil weevil (Gazvin and Karaj)

Chickpeas - bollworm (Karaj)

Beans - Aphids (foliar and seed treatment) (Karaj)
Jassids (Karaj)

A pesticide trial on seed corn maggot Hylemya cilicrura was conducted at Pahlavi University under the supervision of the Entomology Department head Dr. Sharifi.

Dry bean plots had spray applications of aldrin at 5 kilos actual/Ha. and lindane 2 kilos/Ha. incorporated into the soil. However, an infestation of seed corn maggot never developed.

INDIA

General

In 1967 the four senior counterparts to U. S. Technicians in Plant breeding, Agronomy, Pathology and Entomology were officially appointed. However before the end of the year the Entomologist resigned to accept another position. Many other positions in the All-India Coordinated Pulse Project are still vacant including that of Coordinator. The two regional centers and four subcenters as provided for in the Project have not been officially sanctioned and therefore no provisions for work there are available. No progress has been made on construction of the Pulses Research Building. Without this it is very difficult to effect good cooperation and coordination among workers in different disciplines. Physical facilities of offices and laboratories are make-shift and totally inadequate to conduct research on the number of crops and disciplines involved in this program. A request for additional power for the presently occupied laboratories which was made in early 1966 has not been filled. The cold storage facility constructed from RPIP funds in 1967 for germplasm storage is also without power.

The Indian government is extremely slow in meeting its commitments and although there is a great deal of talk there is little action.

The Regional Pulse Improvement Project is using its resources to carry on research at IARI and other Institutions with whatever assistance and support is available from official funds or through voluntary cooperation.

So far we have had more research crop failures than successes. The 1966-67 rabi crop (Planted in November 1966 and harvested in March-April 1967) of the large germplasm collection of chickpeas at Delhi was completely lost primarily due to high salinity in the land assigned for it. A similar fate befell the germplasm collection of pigeon peas due to a killing frost in January 1967.

The 1967 monsoon season with ample rains, although contributing to a bumper foodgrain crop in general, ruined most of the Pulse Project's efforts due to repeated and prolonged flooding of fields at IARI and other locations. Data from many other trials must be considered unreliable because land was not ready in time for planting, labor crews were not available to keep weeds from choking out the crops or irrigation water was not available when critically needed.

On the positive side there are strong indications that pulses are getting more attention than they have so far received. More and more state departments of Agriculture and Agricultural Universities are making appointments of specific pulse crop specialists in breeding and other disciplines where thus far there were either none or they were combined with other crops such as millets. This is the case in the states of Bihar, West Bengal, Uttar Pradesh, Punjab, Andhra Pradesh, Rajasthan, Madras, Mysore.

A pulse crop Workshop was held at IARI in New Delhi in February 1967 attended by about 75 workers from all over India.

BREEDING:

Germplasm collections were enlarged through collections within India, introductions from outside India and through transfer of the RPIP, Iran collections of chickpeas, mungbeans, lentils and cowpeas. Because this is the first time that breeding material is being introduced into India there is a great interest and demand for seed of the collections.

The release of an early maturing variety of mungbean was announced by the Indian Agricultural Research Institute. Besaikhi mung appears to be well suited as a summer crop between the end of wheat harvest in April and beginning of Kharif planting in July.

Several lines of Khesari (Lathyrus sativus) have been found with from a trace to 0.15 percent of the neurotoxic compound, B-N-oxalyl amino alanine. These lines are presently being tested for possible direct use as varieties or as breeding material to help overcome the crippling effect of lathyrism in areas where this crop is grown and consumed.

SOIL AND CROP MANAGEMENT

Considerable increases in yield can be obtained in all pulse crops, using presently available varieties by proper management practices. For instance a yield of 1416 lbs. per acre of chickpea was obtained with 50 lbs. of N and 100 lbs. of P_2O_5 per acre and close plant spacing (12" between rows and 4 $\frac{1}{2}$" between "plants").

With mungbean and urdbean yields of over 1400 lbs per acre were obtained using 100 lbs. per acre NPK fertilizer and 5 x 20 cm. plant spacing (400, 000 plants/A).

Using an early maturing (150 days) variety of pigeonpeas a yield of over 4500 kg/hectare was obtained with high plant populations. The average farmers' yield for this crop using long season varieties (250 days) is less than 1000 kg/hectare In mungbeans and urdbeans also, it was found that short season varieties yield as much as those which occupy the land much longer.

With present emphasis in India on increased foodgrain production, early maturing varieties fit better into multiple cropping systems.

Rhizobial studies with pulses are difficult in India because of the many leguminous crops and weeds present. There appear to be many native rhizobia present which are highly competitive but not efficient in nitrogen fixation.

PLANT PATHOLOGY

Chickpea wilt, probably the most destructive disease of this crop, is due to a complex of several organisms. Two pathogens have been definitely identified. No satisfactory resistance has yet been found.

Pigeon pea wilt causes an estimated loss of 40 million rupees or 2600 metric tons of grain. Development of resistant varieties appears feasible. Studies have been conducted on the presence of different strains of the pathogen.

Some 600 collections of wilted plants were made and isolates obtained from them. Breeding material is being screened for resistance.

Out of 681 lines of mungbeans, 203 showed field resistance to yellow mosaic, 264 to leaf crinkle, and 9 to bacterial blight.

Among 20 released varieties of mungbeans, 2 had acceptable field resistance to 6 serious diseases.

Of 310 urdbean lines screened for virus resistance, 67 had some resistance to yellow mosaic, 172 to leaf crinkle, and several showed varying degrees of resistance to fungal and bacterial diseases.

Two viruses have been isolated from cowpeas. Studies on their specific identification are in progress.

ENTOMOLOGY

Various species of Bruchids are among the most destructive of pulse crop pests. Tests were conducted in 1967 in the field on chickpeas, lentils, and dry peas to evaluate the possibility of field control. Laboratory studies of bruchid control in stored seed were also started in 1967.

No accurate estimates are available of the amount of foodgrains lost due to storage insects It is safe to say however that 5 - 10% is a conservative estimate On the basis of 12 million tons production of pulses in India, 5% means 600,000 tons of high protein foodgrains lost annually. It appears from preliminary results that a safe, easy to use and inexpensive insecticide is available which, with one application to the seed right after harvest, gives long lasting protection.

Field trials were also conducted to find suitable controls for flea beetles which damage kharif (summer) crops of mungbeans, urdbean, and cowpea.

PLANT BREEDING

R. M. Matsuura, Plant Breeder
Counterpart: L. M. Jeswani, IARI

Germplasm

The germplasm collections were enlarged and now include the following material:

Crop	Exotic	Indigenous	Total	Countries Represented
Gram (*Cicer arietinum*)	4817	1803	6620	21
Arhar (*Cajanus cajan*)	107	5028	5135	16
Mung (*Phaseolus aureus*)	216*	475	581	15
Urad (*Phaseolus mungo*)	-	310	310	1
Cowpea (*Vigna sinensis*)	706	716	1422	49
Lentil (*Lens esculenta*)	26*	415	441	-
Peas (*Pisum sativum*)	-	407	407	1
Khesari (*Lathyrus sativus*)	87	752	839	7

* Does not include collections recently transferred from Iran.

The total collection of gram (chickpea) planted in Delhi in November of 1966 was lost due to high salinity in the field assigned for it. It was planted again from remnant seed in November 1967. As far as seed was available parts of the collection were also planted at Hissar (Punjab/Haryana) and Jabalpur (Madhya Pradesh).

The collection of arhar (pigeon peas) which was planted at Delhi in July 1966 was also almost totally lost due to a severe frost in January 1967. Because of the danger of frosts which sporadically occur in Northern India this collection was taken to Hyderabad (Andhra Pradesh) for screening, evaluation and initial seed increase.

The following table indicates the range of variability present:

Character		
Plant height	=	72 cm. to 310 cm.
Flowering	=	66 days to 230 days.
Podding date	=	86 days to 238 days.
Maturity	=	108 days to 250 days.
Pod size	=	2.5 cm. to 8.5 cm.
Seed pod	=	2.3 cm. to 6.7 cm.
100 seed weight	=	4.3 gms. to 20.1 gms.

Normally arhar planted in June/July is not harvested until the following March/April. One of the main objectives in this program is to find varieties which will mature and produce a good crop in about 5 months to fit into multi-cropping systems.

Out of the 5135 lines 27 have been harvested and sent for off-season multiplication in Coimbatore (southern India) to provide sufficient seed for preliminary trials at several locations in 1968.

Breeders from five states visited the nursery in 1967 and requested seed from all or part of the collection.

Collections of mungbeans, urdbeans and cowpeas were grown at IARI, Delhi in the 1967 Kharif season. The collections of lentils, peas and khesari were planted in the rabi (winter) season. In the khesari collection 9 low neurotoxin lines are being tested more extensively. They will also be harvested and analyzed on an individual plant basis.

Coordinated Yield Trials:

The varieties of major pulse crops - chickpeas (gram), pigeon peas (arhar) mungbeans, urdbeans, cowpeas, lentils and peas released by the various state Departments of Agriculture were entered in the All India Coordinated Varietal trials.

Chickpeas	22	varieties,	18	locations
Pigeon peas	16	"	15	"
Mungbeans	20	"	17	"
Urdbeans	16	"	25	"
Cowpeas	8	"	15	"
Lentils	11	"	10	"
Peas	6	"	7	"

Variety Release

The release of mungbean variety Pusa Besaikhi was announced by IARI. It was developed from a selection out of T44, a variety from Uttar Pradesh state.

Although considerable work needs to be done to confirm its characteristics it is early maturing and appears to be well suited for cultivation in the summer months between wheat harvest in April and planting of maize, sorghum or millets in June/July in areas of North India where irrigation is available. In a limited number of tests in 1966 and 1967 it flowered in 45 days and matured in about 70 days, giving a yield of about 1000 kg. per hectare. At present no crop is grown during this period of the year and this variety therefore may provide an additional crop of high protein food grains as well as increased revenue to the farmers.

The demand from farmers for seed has far exceeded the very limited amount of seed (100 kilograms) which was available. This indicates the progressive interest on the part of farmers in new crops, new varieties, and new methods.

Soil & Crop Management

R. J. Davis, Soil Scientist
Counterpart: S. L. Chowdary, IARI

Trials of chickpea (Cicer arietinum) with varying spacings and fertility levels were put out at two locations, Delhi and Pantnagar, in the 1966-67 Rabi (winter) season. The Delhi trial was lost due to salinity and wilt disease. The highest fertility treatment (50 lbs./acre N and 100 lbs./acre P.) with the closest spacings (12" x 4½") gave the highest yield (1416 lbs./acre) at Pantnagar.

In the 1967 Kharif (monsoon) season, trials were put out at 4 locations in North India: Delhi, Pantnagar, Hissar and Ludhiana. Trials were conducted on moong (Phaseolus aureous) and Urd (Phaseolus mungo), both short term (60 day) and long term (120-140 day) varieties. Experiments were NPK factorials (0, 50, 100 kg./hec.) with rhizobial inoculation treated as an additional N treatment with plant spacings (both inter and intra-row) versus fertility levels. The trials were completely ruined by disease at Ludhiana and flooding at Delhi. Two out of eight trials at Pantnagar were lost due to either disease or water. All trials were harvested at Hissar but only two were completely unaffected by weather. Conclusive results must await further experimentation. However, the following trends were noted in the trials harvested. There was some, though not a pronounced, response to fertilizer. There was a response to N but not to inoculation indicating that the native rhizobia although highly competitive with the inoculant were not highly efficient fixers of N. The highest yields were obtained with the highest plant populations (5 cm. x 20 cm. plant spacing).

Therefore still higher plant populations may be necessary for highest yield although these spacings are much higher than those generally used and recommended. 100 kg./hec. NPK (actual element) gave higher yields than 50 kg/hec. (up to 1440 kg./hec. at the highest plant population). The short term varieties yielded as much as the long term ones indicating no need for tying up the land for longer period of time.

Spacing fertility and NPK factorial trials were conducted at two locations, Delhi and Pantnagar, with short term Arhar (Cajanus cajan). All trials were washed out in Delhi. At Pantnagar the spacing trial survived. The usually grown long term Arhar is often killed by frost in North India so cannot be considered a safe crop in this area. There was no response from fertilizer on the highly fertile, nearly virgin Terai soils at Pantnagar. The highest plant population yielded 4552 kg./hec., against an average yield even with long term varieties of approximately 1080 kg./hec. Trials on long-term Arhar were put out at Jabalpur. These suffered some damage due to excess rainfall. These trials are not as yet ready for harvest.

A rhizobial competition experiment utilizing 3 serologically indentifiable strains of rhizobia was put out at Delhi and Pantnagar. The Delhi trial was ruined by flooding. The nodules were harvested from the Pantnagar experiment and preserved by freezing. Laboratory facilities suitable to analyse these are not yet available.

A herbicidal trial put out in the kharif season was also ruined as a valid experiment by the water. However, rough observations were made which enabled us to formulate a treatment which controlled weeds very well

in the 67-68 rabi season.

Trials similar to those conducted with the kharif pulses are being conducted in the present rabi season on gram (Cicer arietinum), peas and lentils. These trials are not yet ready for harvest. However, disease has ruined the gram trials at three locations.

Certain trends are ascertainable from this, the first complete year's data. The present pulse varieties will probably not respond to high levels of fertility. Higher plant populations will give considerably better yields than are now being obtained with good growing conditions. Due to the vagrancies of the weather, the lack of proper drainage, many diseases, plus weed and insect problems it is only a fortunate coincidence when good growing conditions exist. Solving this problem for the research scientist, let alone the individual farmer, will in most all cases depend upon overall integrated programs. The short term varieties of all crops, with proper plant density have the potential of yielding as much as the long term ones which tie up the land for twice as long. Weeds can be controlled sufficiently with weedicides to allow hand weeding to keep up. The native rhizobia though numerous are not always very efficient nitrogen fixers.

Plant Pathology

F. J. Williams - Pathologist
Counterpart: G.S. Grewal - IARI

I. Chickpea (Cicer arietinum) - Our entire planting of chickpea at New Delhi died in March, 1967 because of soil salinity. No diseases were present before the plants were affected by salinity.

Most fields of chickpea were a total loss in 1967 in Punjab (where 5 million acres of chickpea are planted). Wilt was the primary cause, but was accentuated by subnormal rainfall. Fusarium and Operculella were both isolated from diseased plants and were proven pathogenic. Wilt was present in irrigated fields, but at lower incidence, and the loss was negligible. Studies on interactions among soil temperature, water stress and pathogens in the wilt disease of chickpea will be started.

The effect of time of planting (biweekly from Sept. 23 to Dec. 1) on incidence of wilt is being studied at Delhi. To date, the first planting has had the most wilt. Plantings made from October 6 to December 1 have similar incidences of wilt. Yield data will be taken. A trial at Delhi of 18 Cicer varieties showed no difference in resistance to wilt, but the wilt incidence was low.

Of 28 varieties of chickpea screened, 27 were highly susceptible and one moderately resistant to Operculella padwicki. The resistant variety had a seedling kill incidence of 47%.

Gram blight (Ascochyta rabiei), occurs pandemically in Punjab and Himachal Pradesh in some years. When 23 varieties were screened in pot culture, all were susceptible.

II. Pigeon pea (Cajanus cajan) - Extensive surveys were made in Uttar Pradesh, Bihar, Maharashtra, Madhya Pradesh and Andhra Pradesh in those districts where pigeon production is concentrated. Some 600 collections of wilted plants were made and the incidences of wilt, sterility mosaic and yellow mosaic noted. Varieties released as wilt resistant are susceptible to some isolates. Nineteen selections and 6 varieties were tested for resistance to two isolates. Definite resistance was found in 3 varieties and 3 selections. All wilt resistant varieties are being tested to determine if definite strains of the pathogen exist.

Sterility mosaic and yellow mosaic had incidences of a trace to 1%. Cultivators said the diseases were becoming more common each year. Fusarium wilt caused a loss of 1 - 2% in U. P. and about 5% in the peninsular states. In U. P. wilted plants were usually confined to a small portion of a field, as though the pathogen had been recently introduced. In peninsular India entire fields were often affected, with 25 - 100% loss. Conservatively, Fusarium wilt of pigeon pea must cause an average annual loss of 2%. With 1,300,000 metric tons of pigeon pea produced, the annual loss is valued at 40 million Rupees or $5,000,000. Control of this disease by resistant varieties is an attainable goal.

Powdery mildew (Leveillula taurica) has been serious on our pigeon peas at Coimbatore for the past two years. Dusting with sulfur did not result in adequate control and severe defoliation occurred. This disease has not been prevalent in the farmers' fields, but may become so when

the crop is intensively managed for high yields.

Efforts to isolate a virus by the agar column technique from plants with sterility mosaic or yellow mosaic symptoms have failed.

III. Mungbean (Phaseolus aureus) - The genetic material was screened for field resistance. Under epiphytotic conditions, 203 of 681 lines had field resistance to yellow mosaic, 264 had field resistance to leaf crinkle (a new suspected virus disease), and 9 had field resistance to bacterial blight. No line had field resistance to all three diseases, but 3 lines were promising. The breeders have been asked to cross the resistant lines with some of the better varieties. As soon as possible we will find out if the field resistant lines are immune, highly resistant or symptomless carriers of the viruses.

The released varieties of mungbean were screened for field resistance to several diseases at New Delhi and at Meerut, U. P. Of 20 varieties, 2 had acceptable field resistance to 6 serious diseases, but crosses among varieties may result in a higher degree of resistance.

At Jabalpur mungbean varieties were screened for resistance to a leaf spot disease not present in other trials. Three varieties were resistant and three were especially susceptible. Unfortunately, the varieties resistant to the leaf spot are quite susceptible to other important diseases.

Cercospora leaf spot was serious in a few fields in U. P. Spray trials for the control of foliar leaf spots are planned for the 1968 Kharif Season.

IV. Urd bean (Phaseolus mungo) - Yellow mosaic of urd is devastating in parts of Uttar Pradesh. Results from two years testing show that of released varieties the two most resistant to yellow mosaic are highly susceptible to leaf crinkle and the three varieties resistant to leaf crinkle are highly susceptible to yellow mosaic. Studies must be done under insect proof conditions to determine the extent of cross-protection between these two diseases.

The prevalence of yellow mosaic and leaf crinkle have precluded screening urd varieties and germplasm for resistance to other diseases. Some of the diseases known to be serious on mungbean can be expected to become serious on urd when the virus diseases are controlled.

Of 310 lines tested at New Delhi, 67 had some resistance to yellow mosaic, 172 to leaf crinkle and several had some resistance to fungal and bacterial leaf spots. The breeders have been asked to make crosses of the most promising lines.

V. Peas (Pisum sativum) - Tests were planted at Delhi to determine varietal resistance and planting date effect on disease. Powdery mildew, rust and pea streak occurred, but in low incidence. The varietal test showed three introduced varieties to be equal or superior in yield to the indigenous and other introduced varieties. The highest yield was obtained from the second planting date.

VI. Cowpea (Vigna sinensis) - The cowpeas in the germplasm and variety trials had several symptoms of virus diseases. Two viruses, a long flexous rod and a sphere, were isolated from diseased plants using the agar gel column technique. Studies on their identification and control are in progress.

VII. Lathyrrus sativus: Downy mildew (Personospora lethyroides) occurred in an epiphytotic in our Delhi plantings. Some control was achieved by spraying and a change in the weather checked the disease.

Publication: F. J. Williams, J. S. Grewal and K. S. Amin. Serious and new diseases of pulse crops in India in 1966. Submitted to Plant Disease Reporter.

ENTOMOLOGY

K. E. Gibson - Entomologist
Counterpart: P. V. Rangarao - IARI

The opening of the calender year 1967 found the 1966-67 Rabi season about one quarter over. Replicated plots of lentils, gram and dry peas, made available through the co-operation of Uttar Pradesh Agricultural University at Pant Nagar, India, were sprayed 3 times at approximately 2-week intervals, beginning shortly after the first blossoms appeared, early in January, for experimental Bruchid control in the field. Three insecticides were used: DDT Benzene - Hexachloride, and Diazinon. A replicated series of untreated check plots was also maintained.

These plots were harvested in April 1967, and there was practically no Bruchid damage in any of the treatments, nor in the untreated checks. An apparent lack of Bruchid infestation in any of the crops prevented any evaluation of these insecticide treatments for field Bruchid control.

Plantings of cowpeas, mungbeans and urd beans, for the Kharif season were made early in July 1967. These crops were all attacked almost as soon as the plants emerged from the soil, by flea beetles. Damage to foliage was persistent and severe. Two experimental control approaches were tried. A portion of these plantings was sprayed with DDT, and a portion with carbaryl (sevin). Both procedures and results were unsatisfactory, the procedures because of intermittent but frequent heavy downpours of rain, which both interrupted spray schedules, and frequently washed off spray applications; the results, primarily because one of the materials used, namely carbaryl

or sevin, a wettable powder formulation, proved quite phytotoxic to small plants of cowpeas, mung beans and urdbeans when applied as a spray at rates of 1, $1\frac{1}{2}$, and 2 pounds of actual toxicant per acre, under the climatic conditions of extreme heat and humidity experienced here during the Kharif, or summer season.

The second experimental control attempted against the flea beetles was the use of granular formulations of systemic insecticides, applied as soil treatments, dropped intimately mixed with the seed in drill rows at planting time.

Applications of granular thimet (phorate) and temik (UC-21149) at 2 pounds per acre gave out-standing results in exploratory tests. Foliage injury by flea beetles was almost completely absent from treated plots for 6 weeks after planting, while plant foliage in untreated check plots was heavily stippled and damaged by flea beetle attack.

Experimental work along these lines will be expanded during the 1968 Kharif season, within the use of additional materials and dosage rates. This approach to flea beetle control shows much promise.

Plantings for the 1967-68 rabi season were begun in early October with chickpeas, or gram, and carried through into November with the planting of lentils and dry peas. These crops were all planted to be used for insecticide tests against Bruchids (all 3 crops), pod borer (on chickpeas), leaf miner (on peas), and aphids (tests to be made on lentils).

By the end of the year the first insecticide applications had been made to chick peas for Bruchids control, before any appreciable number of blooms had appeared. Succeeding applications, on this and the other crops for Bruchids and the other expected insect pests, were continued into 1968.

Some experimental work directed toward the control of Bruchids infesting mature seed in storage was initiated in the fall of 1967, using 5 per cent Bromodan dust, thoroughly mixed with seed at the rates of 1/2, one and 2 grams of the 5% dust per kilogram of seed. Results at first were erratic and somewhat disappointing, but after obtaining fresh dust, and setting up experiments with adult Bruchids less than one day old (to avoid excessive mortality in checks due to old age of adults), results are looking very promising and encouraging. Bromodan is of a very low order of toxicity to warm-blooded animals (about 12,900 mg. per kg. of body weight - acute oral LD-50), and has a very long residual life, so may prove quite effective for this type of control.

Biological and life history work with the Bruchids under study has also been initiated. The adult life history of some of the species, at least, is relatively short -- only about 7 or 8 days, and mating may take place and eggs be laid within 24 hours after adult emergence.

Both the biological chemical controls aspects of the Bruchid problem will be extensively pursued.

1967 saw the completion of over a year's collection of insects from a black light trap, operated nightly at my home in New Delhi from the latter part of October 1966, until mid-December of 1967, with the exception of the months of April, May and June, 1967, when I was on Home Leave.

These daily collections have been sorted, representative specimens pinned for the Project insect collection, and the remainder preserved in suitable containers for possible future use, or distribution to institutions to which they may have an interest and value. It is felt this material has an intrinsic entomological value and should not be discarded.

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REGIONAL PULSE IMPROVEMENT PROJECT

PASA RA(AJ)-300

USDA/ARS - USAID/WOII

SUMMARY - 1968

IRAN and INDIA

A.I.D.
Reference Center
Room 1656 NS

I R A N

General

A considerable change took place in the operations of the project in Iran during 1968.

The fourth 5-Year Plan went into effect on March 21 and with it the Government of Iran, through the Plan Organization, increased its support to pulse crop research from an average of Rials 2,200,000 ($29,000) per year during the previous four years to Rials 20,000,000 ($270,000) for 1968/69 and projected Rials 12,000,000 ($160,000) per year for the remaining four years of the Plan period. With this Iran assumed the responsibility of the major share of local costs of the Pulse Project. The funds are administered through Karaj Agricultural College which thereby has assumed control over local personnel, procurement and other project operations. Technical control and execution of the research program still rested with the American team but toward the end of the year a committee of Karaj College staff began to participate more actively in project affairs. A re-organization of Iran's universities and colleges with greater stress on the importance of research may well have contributed to this interest as the pulse project was the most active research program going on at Karaj College.

Early in 1968 the decision was made that the Regional Pulse Project in Iran would be phased out. Although considerable uncertainty existed regarding the exact timing and procedure, by the end of the year it appeared that at least part of the American team would remain for some time.

Dr. Kenneth H. Evans, Plant Breeder, was transferred to take over the breeder's position with RPIP/New Delhi during the summer of 1968, leaving the RPIP team in Iran without a breeder.

A two-day work planning session was held at Karaj in January 1968 to plan and coordinate research activities for the coming season between Karaj College, Ministry of Agriculture and other interested agencies such as Pahlavi University, Dez Irrigation Project & Ghazvin Development Project.

No workshop was held in Iran in 1968 primarily because only one American was present at the most suitable time for the workshop. However a combined seminar-workshop was planned for January, 1969.

In 1968:

(1) Several varieties of pulse crops were named by the Iran Ministry of Agriculture and seed was grown in seed multiplication blocks on Government farms.

(2) Previous data on crop management were confirmed. Maximum yields can be obtained with timely planting, good stands (400-500,000 plants per hectare) and proper irrigation. Nitrogen fertilization has not shown consistent responses indicating adequate nodulation and nitrogen fixation.

(3) Resistance was identified to major diseases in chickpeas, lentils and cowpeas.

(4) Recommendations for pest control schedules were made.

(5) Preliminary screening showed possible resistance to bruchid in cowpeas.

PLANT BREEDING:

K.H. Evans, Plant Breeder*
Jamshid Jafari, Counterpart
Mehdi Khosroshahin "
Ali Ebtini "
Moh. Moadab "

In addition to material collected in Iran five chickpea strains were received from Israel via the Ghazvin Development Project. One strain is reported as resistant to Ascochyta rabiei. Another strain, Bulgarian, also reported as resistant to Ascochyta rabiei was obtained by Dr. Kaiser from Israel.

Germplasm was distributed to the following locations; 215 Chickpea strains to Dr. Koo, Atomic Energy Research Station in Puerto Rico; 70 strains of lentils, beans and cowpeas to Mr. Nihat Canitez, Ministry of Agriculture, Turkey. Seed distributed in Iran or sent to RPIP/India is not listed.

Germplasm of Lens esculenta (lentils) was evaluated at Karaj, Gazvin and Shiraz. Yield trials were grown at nine locations. The small seeded Isfahan types continue to produce yields nearly double those of the large seeded types at Karaj and Varamin. The Isfahan and large seeded types produced nearly equal yields at Gazvin.

Germplasm and selections of Cicer arietinum were evaluated at Karaj and Shiraz. Yield trials were grown at ten locations. Black chickpea strain 416M (accession No. 12-071-05451) was increased by the Iran Ministry of Agriculture after the recommendation made in 1967. In 1968 yield trials it produced slightly higher than average yields.

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* Left Iran in May 1968 for home leave and transfer to RPIP/New Delhi, India.

Germplasm and selections of Phaseolus vulgaris (beans) were grown at Karaj and Shiraz. Yield trials were grown at eight locations. The Iran Ministry of Agriculture planted seed increase of three recommended strains of beans. Red bean accession 65-071-00582 and white bean accession 65-071-00042 continued to yield well, but are exceeded by newer selections. Pinto bean accession 65-071-00446 is susceptable to virus and produced low yield.

Germplasm and selections of Vigna sinensis (cowpeas) were evaluated at Karaj and Shiraz. Yield trials were planted at eight locations. Three cowpea strains (accession 62-153-00057, 62-071-10003 and Early Ramshorn) were increased by the Iran Ministry of Agriculture for possible release. All three strains yield well in absence of cowpea mosaic virus. Accession 62-153-00057 and Early Ramshorn are more susceptable to cowpea mosaic virus than accession 62-071-10003.

Germplasm and selections of Phaseolus aureus (mungbeans) were evaluated at Karaj and Shiraz), yield trials were grown at six locations. The Iran Ministry of Agriculture increased two mungbean strains (accession 48-157-10307 and 48-069-10075) for possible release. These two strains ranked 2nd & 4th in yield when Karaj and Varamin results are averaged for 1968.

SOIL AND CROP MANAGEMENT

G.M. Horner - Soil Scientist
M.Mojtehedi - Counterpart

Date of Planting - Based on results for 1966 to 1968, the optimum planting dates for pulse crops in the Karaj area are as follows:
before mid-March (or as soon as possible thereafter) for lentils, the first two weeks of April for chickpeas, first two weeks of May for dry beans and cowpeas, and the first three weeks of May for mungbeans. Planting dry beans, cowpeas, or mungbeans as early as mid-April usually resulted in poor stands.

Plant Population - Maximum yields were obtained with a plant population of 500,000 plants per hectare (50 cm row spacing) for chickpeas and dry beans and with 400,000 plants for cowpeas.

Irrigation - Highest yields of chickpeas, dry beans, and cowpeas were obtained by maintaining soil moisture at a level not less than two-thirds of field capacity. To maintain this level, it was necessary to irrigate every 6 or 7 days, except early in the crop season.

Considering total crop production, however, the high moisture treatment will not utilize irrigation water efficiently where the quantity of water is insufficient to irrigate all the land available for cropping. With dry beans, for example, irrigating every 14 days (half as often) reduced the yield only 25% below that for the high moisture level. Using the same amount of water on a larger area (with fewer irrigations) would result in greater total production. Therefore, the relationship between the amount of water and the amount of land available should be considered in determining irrigation practices.

PLANT PATHOLOGY

Walter J. Kaiser, Plant Pathologist
Dariush Danesh, " "
Mahmoud Okhovat,

Virus diseases were widely distributed and of primary importance in the cultivation of several pulse crops grown in Iran during 1968. Foliar diseases caused by fungi were of minor importance, except for blight of chickpea.

Beans (Phaseolus vulgaris) are cultivated in several regions of the country, and under natural field conditions are infected by four viruses - bean common mosaic (BCMV), bean yellow mosaic (BYMV), cucumber mosaic (CMV), and pea leaf roll (PLRV). All bean viruses are aphid transmitted, but only BCMV is transmitted through the seed. Inoculation studies were conducted in the field with several isolates of BCMV, BYMV, and PLRV, and three bean varieties at different stages of plant growth. Seed yields were reduced 23-99% with BCMV, 11 to 87% with BYMV, and 96-99% with PLRV. Yields were generally less in plants infected before flowering. Bean common mosaic virus, the most important and widespread virus disease of beans in Iran, is introduced into a field at the time of planting in seed previously harvested from virus-infected plants. The virus was seed-borne in up to 20% of bean seed present in bazars from various bean growing areas of the country, and caused subsequent yield reductions of 0 to 81% in virus infected plants. Two bean lines in a replicated variety trial in Khuzestan were highly resistant to BCMV under field conditions of high disease incidence. Pea leaf roll virus infected 21% of 1292 bean lines grown in yield and observation trials at Karaj and 98% of 78 bean lines in Khuzestan.

Broadbean (Vicia faba) yields can be drastically reduced by foliar diseases caused by fungi (rust and chocolate spot) or by virus diseases, the most important being caused by BYMV and PLRV. Virus diseases occur yearly regardless of the weather, but rust and chocolate spot are of no consequence in the absence of frequent rainfall. In field and greenhouse tests no resistance to BYMV and PLRV was found in 106 broadbean lines. The effect of BYMV and PLRV on growth and yield of broadbeans was studied in greenhouse and field inoculation tests. Depending on the stage of growth at the time of virus infection, seed yields were reduced by 3 to 40% with BYMV and 88 to 99% with PLRV. Bean yellow mosaic virus was seed-borne in 1.5, 0.25, and 0% of the seed from broadbean plants infected at the pre-bloom, full bloom, and post bloom stages of growth, respectively. Pea leaf roll virus was not found to be seed-borne in broadbeans.

Chickpeas (Cicer arietinum) are naturally infected by four viruses -- AMV, BYMV, CMV, and PLRV. Weeds and other leguminous plants are important reservoirs of these viruses. Ninety-four per cent of the plants of a biennial weed (Melilotus sp.) which were indexed for virus in early spring when the plants were resuming growth were infected with BYMV. All viruses infecting chickpeas are aphid-transmitted, but apparently not seed-borne. In field inoculation studies, the four chickpea viruses reduced seed yields from a minimum of 79 to over 99%, and mortality from 0 to 79% depending on the virus isolate and stage of growth at the time of infection. Chickpea blight which infects all above ground portions of the plant is caused by the fungus, Ascochyta rabiei. The disease occurs sporadically in Iran, but can cause substantial losses, as it did in 1968, when environmental

conditions are favorable for spread and disease development (late spring rains and/or high humidity). Preliminary studies in the field biology of A. rabiei have shown that the fungus can survive in diseased plant tissue for an extended period of time under adverse environmental conditions. In greenhouse inoculation tests, a few chickpea selections, especially black-seeded types, have shown resistance to several isolates of the fungus. A culture medium utilizing extracts of chickpea seed has been developed which results in abundant sporulation of the fungus. The spores produced on this medium have been used successfully in the inoculation tests. Studies are also being conducted on the effect of environmental conditions on growth, sporulation and survival of Ascochyta.

Lentils (Lens esculenta) were severely damaged at several locations by virus diseases. The viruses isolated from diseased lentils include AMV, BYMV, CMV, and PLRV. Bean yellow mosaic virus was found in several lentil growing areas of Iran. Although CMV is more restricted in its distribution, it is capable of reducing lentil yields as much or more than BYMV. At Varamin BYMV and CMV were transmitted by aphids throughout a lentil variety trial and drastically reduced yields in most large seeded lentil types, but several small seeded Esfahan types showed a high level of field resistance to virus infection. These Esfahan leptil types are also resistant to root rot under field conditions.

Determinations were made of the protein content of seed from virus infected and healthy pulses. The protein content was 1-3 percent higher in seed from virus-infected plants, but seed yields and seed quality were almost always much greater from healthy plants.

Papers and Publications:

- W.J. Kaiser, Dariush Danesh, Mahmoud Okhovat, and Hossein Mossahebi. 1968. Diseases of pulses (edible legumes) in Iran. Plant Disease Reporter 52(9): 687-691.

- Walter J. Kaiser and Louise Kaiser, 1968. The challenge of overseas work. Phytopathology News. Vol. 2, No. 7 and 8.

- W.J. Kaiser, Dariush Danesh, Mahmoud Okhovat, and Hossein Mossahebi. 1968. Regional Pulse Improvement Project. Diseases of pulse crops (edible legumes) occurring in Iran. Iranian Journal of Plant Pathology 4(3): 2-6.

ENTOMOLOGY

S.W. Wilson -Entomologist
K. Kamali -Counterpart
G.R. Rassoulian -Counterpart

Pest infestations were very limited during 1968. However, the expanded number of field trials and field trial locations resulted in a substantial increase of information needed for pest control recommendations.

Based on the 1968 data recommendations for pest control are as follows:

Crop	Pest	Pesticide	Rate (actual)
Mungbeans	Mites	Kelthane	1 kg/ha
		Ethion	600 gm/ha
		Tedion	500 gm/ha
		Schering 1143	1 kg/ha (experimental use only)
Dry Beans	Mites	Kelthane	1 kg/ha
		Tedion	1/2 kg/ha
		Schering 1143	1 kg/ha (experimental use only)
Dry Beans	Seed corn maggot	Planting should be conducted when the weather is warm enough for quick plant growth or soil temperatures reach 18°C at planting depth.	
	Seed treat with	Dieldrin	0.33 gr/kg of seed
Chickpeas	Cotton boll worm	DDT + Lindane	1500 gm + 450 gm/ha
		Toxaphene	2½ kg/ha
		Sevin	1½ kg/ha
		Supracid	600 gm/ha
Cowpeas	Aphids	Dimethoate	1/2 kg/ha
		Diazinon	600 gm/ha
		Malithion	1 kg/ha.

Continued chemosterilization laboratory trials have had negative results. Continued screening will be conducted during 1969.

Preliminary varietal resistance screening for bruchid resistance on cowpeas shows promise in the laboratory. Field resistance trials will be conducted in the field during 1969 with varieties selected from the preliminary laboratory work.

I N D I A

General

Project activities in India in 1968 continued to be hampered by a serious lack of facilities. Facilities of land and laboratories at the Indian Agricultural Research Institute in New Delhi are totally inadequate for a U.S. team to do active research. The pressure for the land of the research farm is so great that hardly any of it can ever be taken out for uniform cropping. In addition priority for the good land is invariably given to wheat, maize, sorghum & rice. Out of five crop seasons since 1966, the pulse project has seen four complete or near complete failures. Laboratory space was to be provided by the construction of a Pulses Research Laboratory at IARI as provided in the Memorandum of Understanding between the Government of India and USA. However this construction is still in the planning stage. In the meantime the laboratories provided are very over-crowded and inadequate.

The All India Coordinated Pulse Project and research on pulse crops in India in general made significant strides forward in 1968. Many positions on the All India Project were filled; in November the Coordinator was appointed. There are now more people working specifically on pulses than ever before. Several of the Agricultural Universities have or are in the process of appointing pulses breeders, pathologists, entomologists and agronomists. Because of the importance of chickpeas in the Punjab, that State has now separate breeders for that crop by itself.

The capability, technical as well as organization and administrative, to carry on a program is certainly present in India. The presence of the

US team has provided the stimulus to mobilize it. Continued presence of American scientists will help to keep it moving and provide material and other assistance for a strong country program.

During 1968 the question of local rupee funding for the US team was raised and this has brought the matter of its function as a regional research team vs. country support program in focus. This matter is still in the process of being resolved.

The second annual workshop of the AICPP was held in April 1968 while a breeders' meeting took place in August. During the workshop papers were presented and research plans were made by committees of workers in the various disciplines. During the breeders' meeting the All India Coordinated yield trials were planned for the 1968/69 rabi season.

A bibliography of pulse crops is being compiled. When completed and published it should be of considerable value to pulse crop workers all over the world.

The 1968 crop seasons continued to show that pulse crop production is limited to a large extent by unexpected and unavoidable factors. Factors such as unusual cool and wet winter months which delay flowering and reduce yields in chickpeas; nematode infestations, severe monsoon flooding, new as well as known diseases for which there is no treatment or resistance limit kharif crops and an untimely heavy windstorm which halves the yield of arhar.

In spite of these hazards trials showed that:

(1) proper spacing between and within rows increases yields

(2) Fertilization with N, P, and K shows responses

(3) Planting on ridges or beds is advantageous particularly when water logging is a problem

(4) With proper plant densities pigeon peas can produce as good yields in 150 days as in 250-300 days thereby releasing the land in time for an additional wheat crop.

(5) Trials with pulses during the dry early summer season between rabi harvest and kharif planting showed that pulses are more sensitive to environment than was previously believed.

Environmental effects appear to be on both vegetative growth and flowering. Chickpea and cowpea varieties, grown in Iran during the hot dry season, failed during the comparable season in India.

(6) Varieties of pigeon peas can be developed which mature in about half the time of presently grown varieties, are smaller in plant size and produce high yields. Yields between 2000 and 5000 kilograms per acre have been produced in 150 days against an average of about 1000 kg. in 250-300 days. These early varieties would release the land in time for an extra wheat crop. Two such varieties are presently undergoing yield tests.

(7) Resistance to gram blight (Ascochyta rabiei) may be available in varieties brought in from Israel. Thus far no permanent resistance to this very serious chickpea disease had been found.

(8) Resistance to Fusarium wilt in pigeon peas is location dependent, indicating pathogen races. This would explain the susceptibility to wilt of varieties developed with wilt resistance.

(9) Selections can be made which have resistance to several diseases. In mungbean eleven lines showed resistance to four diseases; In urdbean seven lines had resistance to several diseases; 50 cowpea lines were free from bacterial blight and top necrosis. These will be used in crossing programs.

(10) Bruchids, the most serious pests of pulses in storage, can be controlled by good pest control in the field prior to harvest to limit population coming in with the seed. Good control also appears to be possible by treating seed in storage with a hydrocarbon compound (Bromodan, Hoechst Company of Germany). Availability of this material for this purpose however is doubtful.

PLANT BREEDING

K.H. Evans - Plant Breeder
L.M. Jeswani - Counterpart AICPP/IARI

Germplasm

The germplasm collection has been increased by introduction and collections. The total collection is indicated in the table below. In *Cicer arietinum* the collection has been reduced by removing duplicates and bulking similar accessions from identical sources.

Crop	Exotic	Indigenous	Total	Countries represented
Cicer arietinum (Chickpea)	2374	1803	4177	24
Cajanus cajan (Pigeon pea)	108	5130	5244	17
Phaseolus aureus (Mungbean)	1074	526	1647	15
Phaseolus mungo (Urdbean)	-	310	310	1
Vigna sinensis (Cowpea)	707	723	1434	49
Lens esculenta (Lentils)	743	415	1184	-
Pisum sativum (Peas)	-	407	407	1
Lathyrus sativus (Khesari)	87	752	839	7

The *cajanus cajan* (Pigeon pea, arhar) germplasm was grown at Hyderabad in 1967-68 season and a good seed supply was obtained in addition to agronomic data. Bruchid infestation reduced the seed supply in storage, but seed was furnished for four locations in 1968-69; Hyderabad, (A.P.), Varanasi, (U.P.), Jabalpur, (M.P.) and Kampala, Uganda.

In addition partial sets of seed were sent to Pant Nagar (U.P.), Orissa, West Bengal and Bombay (Senegal) West Africa.

The Phaseolus mungo (Urd bean) and Phaseolus aureus (mungbean) germplasm and selections were planted at Delhi, but due to nematodes, disease and other problems, very little seed was obtained. The remaining seed will be divided between two locations in 1969 for seed increase to fill seed requests.

Germplasm of Vigna sinensis (Cowpeas) was planted at IARI Delhi and suffered from problems similar to Urd and Mungbeans, but produced somewhat more seed. Partial sets of cowpea germplasm were also grown at Pant Nagar, Jabalpur, Ludhiana and Hissar. Seed was obtained from Pant Nagar to replenish seed stocks in storage. Vigna sinensis germplasm was also distributed to Thailand, Vietnam, and Senegal, West Africa.
Lens esculenta (lentil) germplasm was planted at Ludhiana (PUNJAB), Berhampore (West Bengal) and Delhi. A lentil strain reputed to be bruchid resistant was obtained from a Hamadan merchant through RPIP Iran and is being tested for resistance.

Germplasm of Cicer arietinum (Chickpea) was grown at Gurdaspur, Ludhiana, Abohar, Pant Nagar, Varanasi and Jabalpur. A set of 43 Cicer accessions were sent to Dr Eddie Echandi, Lima Peru also. Two strains of chickpea were obtained from Israel via RPIP Iran which are reported as resistant to Ascochyta rabiei.

The Lathyrus sativus (Khesari) was planted in Delhi and Jabalpur Selections were made in the low neurotoxin lines and crosses were made to study the inheritance of neurotoxin production.

Seed of five species of beans were obtained for Dr.Bhaduri at Burdvar. Small samples of other seeds were also sent to other location.

All-India Coordinated Yield Trials

These trials, which include varieties, released or considered for release, by various state agencies, were continued essentially unchanged.

The Plant Breeding Working Committee decides the varieties and locations during the annual workshop conference. The following varieties and locations were planned :

Rabi 1967-68

Chickpeas	22	varieties,	18	locations
Lentils	11	"	10	"
Peas	6	"	7	"

Kharif 1968

Pigeon peas	-	early maturing	6	varieties	21	locations
		medium "	10	"	23	"
		late "	8	"	23	"
Mung beans			14	"	35	"
Urd beans			16	"	34	"
Cowpeas			10	"	23	"

A set of uniform data sheets and background information forms were developed and included with seed shipments to facilitate the taking of data and having them returned to the AICPP coordinating office.

Other activities

Germplasm of mungbeans, urd beans, cowpeas, and chickpeas, were planted in March at Delhi for evaluation for the short 60-70-day season between rabi harvest and kharif plantings. The cowpea material did not even begin to bloom in the time available and the chickpea lines died. A

considerable number of line and plant selections were made in the mungbean germplasm. These were planted again in the regular kharif season and will be evaluated at one or more locations in 1969.

Several very early maturing strains of pigeon peas were selected from the germplasm. These were increased and are to be included in preliminary yield trials. Most outstanding among these were P4758, P4785 and P4839. In the 1968-69 season a study was started to determine the amount of natural crossing, an important consideration in maintaining purity in breeding material. Crossing work was also started in this crop to combine various desirable characteristics with earliness.

Papers and Publications

- Report on the results of the All-India Coordinated Varietal Trials. L.M. Jeswani, Proceedings 2nd Annual Workshop Conference on Pulses, Delhi, April, 1968.
- Some considerations on reorientation of research on genetic improvement of pulse crops. L.M. Jeswani, Proceedings 2nd Annual Workshop Conference on Pulse Crops. Delhi, April, 1968.
- Handling of the introductions and their distribution to the breeding centers. P.H. van Schaik, Proceedings 2nd Annual Workshop Conference on Pulse Crops, Delhi, April, 1968.
- Jeswani, L.M., van Schaik, P.H., Coordinated pulse project - its prospects. Indian Farming. February, 1968.
- Pulse Crops - P.H. van Schaik, Proceedings Summer Institute on Plant Disease, IARI, New Delhi, May, 1968.

SOIL AND CROP MANAGEMENT

R.J. Davis, Soil Scientist
S.L. Chowdhury, Counterpart
AICPP/IARI

Rabi 1967-68, Summer 1968, Kharif 1968

Rabi 1967/68

Experiments were conducted at four locations during the 1967-68 rabi season. Spacing experiments in which spacing between rows and between plants within the row were varied at three levels of fertilizer application and fertility expriments in which three levels of N, P, and K and rhizobia inocculation combined factorily were conducted at all locations. The experiments were conducted with chick pea (*Cicer arietinum*) at each location. Vegetative growth of chick peas was very vigorous. The entire crop succumbed to disease at Hissar, Ludhiana, and Pant Nagar. At Delhi the crop remained in a vegetative condition long past normal flowering time. Seed set was light and yields low. Lentils (*Lens esculenta*) were planted at two locations. At Pant Nagar the crop was lost due to 2,4-D spray. At Ludhiana growth was very poor and yields low. Field peas (*Pisum sativum*) were planted at Hissar and Pant Nagar. Good yields were obtained at both locations. Highest yields were obtained with a spacing pattern of 45 cm. between rows and 10 cm. between plants in the row with an application of 50 kg/ha. of N, P, K. With application of 0 and 100 kg/ha. N, P, K yields decreased. There was no effect due to either N,P,K or rhizobial inocculation in the fertility experiments. There was interaction between N,P, and K.

At Delhi an experiment was conducted to check broadcast versus deep placement of super phosphate fertilizer at various levels. A response to fertilization was obtained but there was no difference between the two methods of application.

A chemical weed control trial was conducted at Delhi with chickpea, lentils, peas, and khesari (Lathyrus sativus). Five herbicides were used including the one being used routinely on all of the experiments based on past studies. None of the herbicides treated were superior to this material.

Summer - 1968 (March-July)

In the 1968 Summer season three varieties of mungbean (Phaseolus aureus) were used in an experiment with varying between row and within row spacings at three levels of fertilizer application. Sowing was accomplished in mid-March at three locations. Stand and growth was poor so two locations were replanted in mid-April but again growth was poor. The planting was repeated in Delhi in mid-May and good vegetative growth resulted but only one variety set seed. An irrigation experiment was planted in Delhi in March. Here also growth was very poor. The crop flowered but the small plants produced only 2-4 pods per plant.

From this season's data it is obvious that Kharif pulses cannot arbitrarily be planted in the summer season. There appear to be environmental effects on both plant growth and flowering. More than just photoperiod seems to be involved. The effects are more pronounced the earlier the crops are planted, and there are varietal differences in the effects.

Planting of Iranian chickpea and cowpea varieties in the summer season failed completely despite the similarity of the climate during the India Summer season to that of the normal growing season for chickpeas and cowpeas in Iran.

More detailed studies of the environment-crop interaction under controlled conditions are being planned.

Kharif - 1968

In the 1968 kharif season spacing-fertility trials and fertility-inocculation trials as described under rabi season were conducted on mungbean (*Phaseolus aureus*), urd bean (*Phaseolus mungo*), pigeon pea (*Cajanus cajan*) and cowpea (*Vigna sinensis*).

Trials with mungbean and urdbean were conducted at Delhi, Hissar, Kanpur, Ludhiana, and Pant Nagar. At Delhi trials were conducted on four varieties of mung bean and three varieties of urd bean. The entire crop was lost due to nematode damage. At Hissar where very good growth of these crops was obtained in the 1967 season growth was poor and yields low in 1968. At Kanpur a flash flood due to a heavy rain washed out the crop. At Ludhiana the problem of establishing a stand, encountered last season, was eliminated by use of a soil fumigant. About flowering time the plants became unthrifty apparently due to nematode infestation and yields were neglegible. At Pant Nagar vegetative growth was very vigorous, but yields were low. There was no effect due to fertilization.

Trials were conducted at Delhi on two varieties of cowpea. This crop was lost due to nematode infestation.

Experiments with pigeon pea were conducted at four locations. Two of these were in the frost free zone so that long term and short term varieties could be compared. The other two locations were in the area of frost danger so only a short term variety was used.

Long term varieties are still in the field and will be reported with the 1968-69 rabi crop. Short term variety T-21 of pigeon pea last season yielded as high as the long term varieties usually do when grown in the frost free zone. This gave the possibility of getting the same yield without tying up the land for two seasons.

At Hyderabad irrigation water became unavailable after the sixth week. The growth was slight and yield low.

At Kanpur and Delhi a wilt-like disease not previously known wiped out the experiments.

Growth at Pant Nagar was very vigorous but a storm knocked off many blossoms reducing yields to less than half those obtained last year. Yields were in the range of 2000 kg/ha. which is still twice the average Farmers' yields. There was no effect due to fertilization but a decrease in yield was noted with decreasing plant density.

In a fertilizer placement experiment with T-21 pigeon pea at Delhi in which farm yard manure and super phosphate were broadcast and deep placed (25-30 cm.), an increase in yield was obtained with deep placement.

A chemical weed control trial was conducted at Delhi with twenty treatments on pigeon pea, cowpea and mung bean. The crop was lost to disease but data was obtained on weed control and herbicidal toxicity to seedlings. No treatment was superior to Treflan, the herbicide we are now using.

An experiment was conducted at two locations on the effect of Simazine on the protein content of mung bean and cowpeas. Low levels of Simazine have been reported to increase protein content of crops. This was part of an all-India Program on many crops in which the Pulse Project agreed to participate. No meaningful data was obtained from the first season's trials.

An experiment was conducted on the foliar application of phosphate fertilization with mung beans in the Zyad season and urd beans in the kharif. No enhancement of phosphatic fertilization was noted due to foliar application.

An experiment was conducted to evaluate the effect of flat sowing, ridge sowing, and flat sowing and subsequent ridging on yield of pigeonpea, mung bean and urd bean. Under the conditions of this experiment with the soil waterlogged through much of the growing season but no standing water present, ridging gave higher yields.

A project on environmental studies on plant growth was initiated with the 1968 kharif season with the following objectives:

(A) Collecting and recording as much environmental information as possible in the pulse experimental plots and obtaining other data from available sources and filing permanently for use by members of the project.

(B) Constant surveillance of the crops for any abnormalities and attempting to correlate these with the environmental data collected.

(C) Judicious modification of the environment where possible in the field, &

(D) Growth chamber studies with varying plant environments. A plant growth chamber has been designed and is being constructed using entirely indigenous

material available in India without foreign exchange or import license.

The following papers were either presented or published by members of the Soil & Crop Management discipline during 1968.

(1) Chowdhury, S.L., and Mukhtar Singh (1968)
The problem of water management in rice crop.
Indian chemical Manuf. vol. 6 (2) : 32-36, Feb., 1968.

(2) Bains, S.S., Chowdhury, S.L. and Dayanand (1968)
Relay cropping - Possibilities and Profits
Ind. Fmg. XVIII (4) : 31-34, July - 1968.

(3) Chowdhury, S.L., (1969)
Problems of Pulse Production in India
Crops in India vol. 1 (3 & 4) : 20-22, July-Dec., 1968.

(4) _____, (1968) Cultural practices under rainfed farming.
Paper presented at the Annual Conference of the Indian Society of Agronomy, U.P. Agricultural University, Pant Nagar, Oct., 1968.

(5) _____, (1968) Pulse Crops are a neglected
Loc. Ind. Fmg. 18 (8) : 25-28 Nov., 1968.

(6) Davis, R.J. Report on the results of the Coordinated Agronomic Trials.
Proceedings, 2nd Annual Workshop Conference on Pulses, New Delhi, 1968.

(7) Chowdhury, S.L. The State of knowledge concerning nutrition, plant population and other agronomic aspects of pulse crops in India.
Proceedings, 2nd Annual Workshop Conference on Pulses, New Delhi, 1968.

(8) Saraf, C.S., and Dastane, N.G. (1968) - Water Use patterns in Maize-Cowpea mixtures under varying fertility conditions.
Paper presented by Mr. J.K. Jain, Irrigation Advisor to G.O.I. and the Leader of Delegation at the 7th NFSA Regional Irrigation Practices Seminar, held at Lahore (Pakistan), September, 22-30, 1968.

PLANT PATHOLOGY

F.J. Williams - Pathologist
J.S. Grewal - Counterpart, AICPP/IARI

Rabi - 1967-68

Cicer arietinum (Chickpea)

Treating Cicer NP-58 seed with fungicides increased percent germination, but did not result in increased yields at Delhi. Captan treatment resulted in highest percentage germination.

Fusarium wilt was insufficiently severe at Delhi to effectively screen 18 varieties of Cicer for resistance. At Hissar, the Cicer germplasm was screened for wilt resistance. Of about 5000 lines, 220 were selected as possible sources of resistance and are being tested again for further selection.

The time of planting of Cicer NP-58 did not significantly affect incidence of Fusarium wilt or Sclerotinia wilt at Delhi. Disease incidence was low. Plantings were made fortnightly from September 23 to December 1. Yield was highest from the October 6 planting.

Irrigation of Cicer NP-58 at time of podfilling resulted in premature death of plants at Delhi. There was abundant soil moisture at time of irrigation. The soil was a heavy clay and the plant roots apparently suffocated. Yields from non-irrigated ridged plots were 30% higher than from non-irrigated, non-ridged plots.

Chickpea blight (Ascochyta rabeii), was serious in Punjab, occurring in epiphytotic form on heretofore resistant varieties. There is evidence of 2 or more races of the pathogen. Isolations were made from 60 varieties,

the cultures mixed and 160 lines of germplasm inoculated. Two exotic lines were resistant and are being crossed with previously existing varieties to combine sources of resistance. Some 1500 lines of germplasm at Gurdaspur, Punjab have been inoculated with the mixture of isolates. Current research includes race and differential variety identification.

Several Cicer plants have been seen with virus-like symptoms. One was successfully transmitted mechanically. None are of sufficient incidence to be important at this time.

Pathogenicity of Fusarium isolated from wilting Cicer plants has been erratic. Many isolations made in 1966 could not be proven pathogenic. In 1967 more isolates were made and 3 were pathogenic when tested under field conditions. These isolates have retained their pathogenic character when tested in pot culture and are being tested in the field in 1968-69. If they are pathogenically stable, the germplasm can be screened for resistance.

Cajanus cajan (Pigeon pea)

With evidence that resistance of Cajanus to Fusarium wilt is location dependent (indicating pathogen races), the two major Cajanus growing areas of India were surveyed in 1967-68 rabi season. Some 600 isolates of Fusarium were obtained. Current research includes proof of race existence by testing pathogenicity of several isolates on several varieties. Future research will involve finding geographic distribution of races and development of resistance to specific races of the wilt pathogen.

Many reciprocal grafts between healthy and yellow-mosaic-affected Cajanus plants were made at Hyderabad. Because of a high incidence of yellow mosaic in healthy to healthy grafted controls, the viral nature of yellow mosaic was not proved conclusively. The grafting work will be continued.

A new disease of Cajanus, suspected to be virus induced, was seen at Hyderabad. Symptoms include leaf rugosity and malformation. Reciprocal grafts between healthy and diseased plants were unsuccessful. The diseased plants are being maintained for additional grafts when a new flush of growth occurs.

A new disease of Cajanus was seen at Delhi, and at Deeg and Kanpur in Uttar Pradesh. Gross symptoms resembled those of Fusarium wilt, and the two diseases can be discerned only by careful examination. The new disease is a collar and stem rot, caused by Pythium sp. It occurred only in plantings that had been subjected to flooding for a period of 2 or 3 days (This is not unusual in bunded fields during the monsoon). The pathogenicity of the fungus was proven repeatedly by inoculating healthy Cajanus stems and by infesting soil. A paper on the occurrance of the disease, symptomatology, pathogen identification, etiology and resistance is being prepared.

Kharif 1968

Phaseolus aureus (Mung)

The mung germplasm was screened for resistance to several diseases under field conditions at Delhi. In each disease, further testing under controlled screen-house conditions will be essential before resistance can be identified with certainty.

Six lines were free from yellow mosaic, 48 were free from leaf crinkle (suspected virus), 7 were free from top necrosis (cause unknown), and 7 were free from bacterial blight. Eleven lines were identified that had some resistance to all the diseases.

Some 30 single plant selections were made in 1967 on the basis of multiple disease resistance. In 1968, 4 selections were free from yellow mosaic, 7 were free from leaf crinkle, 25 were free from top necrosis (cause unknown), and 27 were free from bacterial blight. These selections will be used for crossing in 1969.

The varieties of mung in the coordinated trials were scored for diseas. resistance at several locations. No important departures from previous years' performance was noted. Cercospora leaf spot was serious at two locations in Uttar Pradesh for the first time. There was considerable variation in susceptibility among varieties.

Seed of mung variety T-51 was treated with several fungicides and planted at 7 locations. Results were received from 4 locations. None of the treatments resulted in increased germination.

Mung variety T-2 was sprayed at 10-day intervals with 5 different foliar fungicides at 6 locations. No treatment effectively controlled foliar diseases at any of the 4 reporting locations. The 10-day interval was apparently too long for monsoon conditions. The trial will be repeated with a shorter interval and the addition of stickers.

Phaseolus mungo (Urid)

Some 400 lines of urid germplasm were screened for resistance to several diseases under field conditions at Delhi in 1968. The screened material included some single plant selections (based on disease resistance), made in 1967. Thirty lines were free from yellow mosaic, the most serious disease of urid in India. Seven lines were identified as having resistance to several diseases. They must be tested under controlled conditions.

The urid varieties in the coordinated trials were screened for disease resistance at several locations. No departures from previous years performance was noted. Leaf spot diseases (primarily Cercospora), were serious at two locations in Uttar Pradesh. Variation in varietal susceptibility was noted.

Treating urid variety T-27 with any of several fungicides did not significantly increase germination at any of 4 locations.

Vigna sinensis (Cowpea)

The germplasm of cowpea (about 1200 lines), was screened for disease resistance at Delhi under field conditions. Bacterial blight was serious and 137 lines were free from the disease. Top necrosis (cause unknown), was serious. Some 50 lines were free of both diseases and will be tested for resistance to bacterial blight under controlled conditions.

Seed of cowpea (variety Mashad), were treated with several fungicides and planted at 7 locations. Of 4 locations reporting results, several fungicides significantly increased germination at two locations. Captan was as effective as any treatment and has been recommended since it is readily available.

Pisum sativum (Pea)

Several tests were conducted with peas, including variety tests and time of planting experiments. No serious diseases occurred and no significant results for pathology were obtained. A trace of pea streak was present and the virus was mechanically transmitted to healthy plants. Varieties Bonneville, Bridger and 326 yielded best. Varieties Early Badger, Early December and Early Frosty yielded poorly (They flowered after very little vegetative growth when planted at Delhi on October 6).

Important diseases of unknown etiology

In the past 2 years several diseases (causing serious damage to urid, mung, cowpea and Cajanus), have occurred, with which we have been unable to prove the association of a specific pathogen. In each case, many isolations from diseased plants, or grafts between diseased and healthy plants, as appropriate, have been made in attemps to identify the pathogens involved. Lacking effective facilities, all attempts to prove pathogenicity must be done under field conditions with the accompanying uncertain results. A screen-house has been constructed and should be useful during the kharif season for virus work, but the lack of glasshouse facilities precludes important off-season work with kharif crops.' Growth chambers have been ordered to extend the pathology work on Cicer into the off-season and to study the important effects of environment on Cicer wilt. Generally, the lack of minimal facilities has greatly retarded important work in pathology.

Papers and Publications

- F.J. Williams; J.S. Grewal and K.S. Amin, 1968 Serious and New Diseases of Pulse Crops in India in 1966. Plant Disease Reporter 52:300-304.
- F.J. Williams and J.S. Grewal. Screening the world genetic stock of pulse crops for disease incidence and identification of sources of resistance for the utilization in breeding programs. Proceedings Second Annual Workshop Conference on Pulse Crops, New Delhi, April, 1968.
- F.J. Williams. Present status of pathological studies in respect of virus diseases with special reference to mung, urd, cowpea, and sterility mozaic of arhar. Proceedings Second Annual Workshop Conference on Pulse Crops, New Delhi, April 1968.
- F.J. Williams. Plant Diseases. Annual Conference, Office of Agricultural Development, USAID/India. 1968.

ENTOMOLOGY

K.E. Gibson - Entomologist
H.P. Saxena 1/ - Counterpart
AICPP/IARI

Rabi 1967/68

During the first four months of 1968, the three rabi or winter crops that had been planted in October and November, 1967, were given normal cultural care, experimental insecticide sprays were applied for insect control, and harvest of the mature seed was completed during the latter part of April and early May, 1968. The 3 crops were gram (chickpeas), dry peas, and lentils. Foliar sprays of 9 different insecticides were applied to chickpeas for control of bruchids in the field, and for pod-borers; to dry peas for bruchids and a dipterous leafminer and to lentils for bruchids and aphids.

Bruchid damage and pod-borer damage in all the experimental chickpea plots was very low, including the untreated checks, and there were no significant differences in the amount of seed damage due to bruchids or pod-borers, between the various insecticide treatments. Low damage in check plots may have been due to spray drift into them, when applications were made on windy days to other plots.

The dry pea plots also showed relatively little bruchid damage in either sprayed or check plots. The damage ranged from approximately one, to slightly over two percent in the seed samples. Yield records from dry pea plots sprayed for leaf-miner control, showed all treatments except one (Metasystox), to have produced appreciably higher yields than the untreated checks.

1/ Joined the All India Coordinated Pulse Project in July, 1968.

The incidence of bruchid damage was also very low in the seed from the experimental lentil plots, including untreated checks.

The lentil plots sprayed for aphid control showed from about 2½ to 3½ times greater yields than the check plots. Since the aphid populations never built up to appreciable numbers, the beneficial effect must have been due to the control of some insidious and unknown pest.

During the latter part of January, February, March and early April, a program of sweeping the above crops, as well as a planting of Lathyrus sativus, was carried on, to quantitatively determine the incidence of adult bruchids on these crops in the field. From 19 January to 9 April, 1968, bi-weekly sweepings were made in all 4 crops, totaling 50,500 sweeps for the entire period. It was definitely established that bruchid adults were present in all four of these crops during the sweeping period. While not present in large numbers, nevertheless these field infesting bruchids were a proven, potential source of infestation of mature seed when it was harvested and brought into storage.

Kharif 1968

During the kharif season of 1968, four granular systemic insecticides were tested at 4 rates as soil treatments for the control of flea beetles (Madurasia obscurella Jacoby), which are a perennial, serious pest of pulse crops in the kharif season, from the time the plants first emerge from the soil, until about 2 months later. The insecticides used were Disyston, Solvirex, Temik, and Thimet. The application rates were 1/2, 1, 1½ and 2 pounds of actual toxicant per acre. These materials caused

some phytotoxic symptoms in the plants grown on treated plots. The symptoms did not appear to be serious, consisting of tip and edge -burning of the foliage, and the plants soon apparently outgrew them. Flea beetle control was quite satisfactory; there was some early leaf injury, but it was insignificant. Somewhat later there was an amazing growth response to these granular, systemic insecticide soil treatments, and the plants on treated plots outgrew the untreated check plots. This cannot all be attributed directly to insect control, and is a matter of considerable interest. A heavy infestation of soil nematodes was discovered before the plants began to mature, and resulted in the early death of many plants, which greatly reduced yield in certain areas. The startling results of this experimental work justify its being repeated again next year.

A foliar spray of DDT (0.75 pound actual toxicant per acre) plus Thiodan (endosulfan) (0.50 pound per acre) also proved very effective against these flea beetles.

Experiments in field bruchid control on both cowpeas and mung beans, indicated that of 5 insecticide treatments used, the most promise was shown by Thiodan or a combination of Thiodan and DDT.

Laboratory experiments testing Bromodan, a chlorinated hydrocarbon, formulated as both a 5 percent dust and a 50 percent wettable powder, as a protectant for mature pulse seeds in storage, against bruchid attack, have shown the material to have much promise. When used at the rate of 1/2 to 1 gram of actual toxicant per kilogram of mature seed, and intimately mixed with the seed, it kills 95 to 100 percent of bruchids infesting the seed

in 24 hours. It has no ovicidal properties, but does have a relatively long life, and is very effective against both adults and larvae. It shows much promise in keeping infestations from building up to large numbers, or even surviving, in lots of mature seed. It is relatively safe material, having an acute oral LD-50 of approximately 5000 milligram per kilogram of body weight, according to the producers, Hoechst Pharmaceutical Co. of West Germany. Research work on this promising material will be a major entomological effort in the immediate future. Availability of this material appears to pose a problem.

A black light (20 percent ultra-violet light) insect trap has been operated nightly throughout the year in various pulse crop plantings. The insect catches are sorted; series of the various species, genera, families and orders of insects, pinned and labelled for the Project insect collection, the excess stored for future reference, and 112 different lots of economic insects have been sent to the National Museum in Washington, D.C., and identifications made and returned for the Project files.

Papers and Publications:

- K.E. Gibson. Identification of pest problems of pulse crops, Proceedings Second Annual Workshop Conference on Pulse Crops, New Delhi, April, 1968.
- K.E. Gibson. Research on pulse insects. Annual Conference 1968. Office of Agricultural Development, USAID/India.

QUALITY

O.A. Krober - Biochemist
Counterpart - None

The main emphasis of this phase of the work is (1) on screening germplasm collections to identify high-protein breeding material and (2) on analyzing for protein the varieties tested in the multi-location varietal trials to determine protein content as affected by variety and location.

The physical facilities, equipment and staff available are too limited to permit much actual research on protein and component amino acids.

The protein content was determined for all samples of pulse crops from the All India Coordinated Variety Trials which were suitable for chemical analysis. Some samples were obviously seed mixtures, others were so badly damaged by insects that they would not give satisfactory evaluation of the genetic material. Most seed lots coming in from trial locations were incomplete with samples from varieties entered in the trials missing.

Results of these analysis should enable the plant breeders to identify high protein lines. However due to the condition of the seed and the many missing samples, statistical analysis of the data was not possible and no reliable, final conclusions could be drawn from them.

However the data did indicate that a range of protein content exists in the present Indian varieties although no outstanding variety in this regard is available.

Four sets of samples from simazin trials were analyzed for protein content. One set each of green gram and cowpeas grown at Hyderabad and Delhi were analyzed. In general there was little evidence of any marked increase in protein content due to simazin treatment. However a few cowpea samples were somewhat higher in protein than the check sample.

Several sets of samples were analyzed by the official Kjeldahl method using Cereal Laboratory equipment. Duplicate samples were analyzed with the Udy Analyzer for calibration of the Udy equipment.. The analytical work has been greatly handicapped by the long delay in the delivery of essential equipment. Equipment which was requested in the summer of 1967 was not delivered until late in 1968. Much of the work has been done with equipment and facilities borrowed from the Cereal Laboratory at I.A.R.I.

We have developed and used methods for the determination of protein in pulse materials using (1) Macro Kjeldahl, (2) Micro-kjeldahl digestion and distrillation (3) Microkjeldahl digestion and calorimetric determination with Technicon Auto Analyzer and (4) Udy dye-binding method.

Since the Udy equipment was received without the necessary conversion tables it was necessary to calibrate the instrument by analyzing samples of each of the pulse crops by standard methods and then with the Udy equipment.

Germplasm collections are presently being screened for protein content.

Papers and Publications:

- Nutritional Quality in Pulses - paper presented at a Symposium on "The Nutritive Value of High Yielding Strains of Cereals and Pulses" sponsored by the Nutrition Society of India, October 1968.
- Nutritional Quality of Pulses - Proceedings 2nd Annual Workshop Conference in Pulses, New Delhi, 1968.

Bector/