

Awards achieved for the research work done:

1. The Government of Gujarat has conferred 'Sardar Patel Agricultural Research' Award for the year 1998-1999 to Dr. G. L. Maliwal, Dr. A. Das, Shri K. S. Parmar, Shri J. H. Vaghani, Shri C. T. Chand and Dr. M. S. Jakasaniya for outstanding contribution towards Agricultural Development Research and Technology in the field of Agronomy and Soil Science.
2. The Government of Gujarat has conferred 'Sardar Patel Agricultural Research' Award for the year 1999-2000 to Shri D. P. Gohil and co-workers for their outstanding work on chickpea varietal improvement and release of new variety Gujarat Gram-2 in the subject of Research on Plant breeding and Genetics.
3. The Government of Gujarat has conferred 'Sardar Patel Agricultural Research' Award for the year 2000-2001 jointly to Shri J. B. Raol, Dr. P. T. Patel, Dr. L. P. Singh, Dr. R. F. Suthar, Shri M. D. Vora and Shri K. V. Vala for developing a bullock driven seed cum fertilizer drill suitable for *Bhal* area in the subject of Research on Agronomy, Soil Science and Agricultural Engineering.

Research achievements

Wheat

Optimum sowing time for *rainfed* wheat is first fortnight of November (9th November). Under inadequacy of soil moisture, sowing should be started after 20th October.

Seed rate of 60 kg/ha for Gujarat Wheat- 1 is optimum to achieve higher yield under conserved moisture condition.

Application of 20 kg Nitrogen (N) per hectare and 15 kg Potassium per hectare (P_2O_5) at the time of sowing is economic dose for *rainfed* Gujarat Wheat- 1. Foliar application of Nitrogen was not found beneficial to this crop.

Intercropping of wheat and safflower in 3:1 row proportion is found remunerative.

Three irrigations each of 50 mm from harvested rain water at tillering, flowering and grain formation stages increased wheat yield up to 177 percent where pond water is available. If water is available for a single irrigation, it should be applied at maximum tillering stage for getting higher yield. Irrigating the crop at crown root initiation stage is equally beneficial and may be preferred in order to avoid evaporation loss from farm pond. In absence of pond water, underground saline water may be used along with soil amendment (Pressmud @ 10/ha or gypsum @ 6 t/ha) for irrigating wheat crop (3 irrigations each of 50 mm at tillering, flowering and grain formation stages) to sustain the production during drought year.

Dusting of methyl parathion 2 percent dust on bunds surrounding wheat crop should be carried out as a preventive measure against surface grass hopper. Further, sorghum which is the ultimate host of the pest should be harvested in time so that adult may die due to starvation in absence of food during the period from harvest of sorghum to sowing of wheat. If the pest appears in the field, dusting should be carried out with 25 kg per hectare as a control measure.

Seeds of Gujarat Wheat- 1 after dried under sunlight coat it by oil with 500 ml per 100 kg seed or mix with dried neem leaves with 2 kg per 100 kg seeds for storage in galvanized bins against lesser seed borer under *Bhal* and Coastal Agro-climatic Zone.

Apply Farm Yard Manure with 5 t per hectare to wheat every year in addition to recommended dose of nitrogen (20 kg/ha) for maintaining organic matter status in the soil.

Coat seeds with phosphate culture, such as *Bacillus coagulans* PBA-14 (Net ICBR 1: 17) or *Bacillus coagulans* PBA-13 (Net ICBR 1: 11) or *Bacillus brevis* PBA-12 (Net ICBR 1: 7) with 6 packets per hectare containing 108CFU per gram carrier to get maximum net realization and yield.

Fertilize Gujarat Wheat- 1 crop with 20 kg Nitrogen per hectare and 40 kg Potassium per hectare and 25 kg Zinc per hectare as basal and 20 kg per hectare at first irrigation to get higher seed yield and net return with two supplementary irrigations (First at Crown Root Initiation and second at 40-45 Days after sowing).

Chickpea

Gujarat Gram- 2 for cultivation under conserved moisture condition, the optimum seed rate is 80 kg per hectare.

Optimum sowing time for chickpea under conserved moisture condition is 21 to 25 October for maximizing the seed yield and minimizing wilt disease.

Optimum seed rate for chickpea cv. Chaffa is 40 kg per hectare to achieve higher seed yield under conserved moisture condition.

Seed inoculation by Rhizobium culture GRS-4 (1×10^8 cells/g) with 200 g per 8 kg seed increase seed yield.

Inter row spacing of 30 cm for chickpea cv. Chaffa increases the seed yield.

Application of 20 kg Nitrogen per hectare at sowing is economic dose for chickpea under conserved soil moisture condition. However, under limited irrigation conditions nitrogen can be increased up to 40 kg per hectare.

One irrigation of 50 mm from harvested rain water applied at maximum branching stage increases seed yield of chickpea cv. Chaffa by 56.05 percent.

Powdery mildew of chickpea can effectively be controlled by spraying Dinocap with 0.025 percent or Wettable sulphur with 0.2 percent or Tridemorph with 0.04 percent twice at an interval of 15 days starting from appearance of disease.

Spraying growth regulators GA3 (25-75 ppm), Kinetin (50-200 ppm), CCC (50-200 ppm) and NAA (10-40 ppm) on chickpea cv. Chaffa at 50 percent flowering and pod formation stages was found not beneficial to increase the seed yield.

Initiate control measure for pod borer *Helicoverpa armigera* in chickpea considering economic threshold level i.e. 20 larvae per 20 plants at vegetative and 15 larvae per 20 plants at pod formation stage.

Practice following module for effective and economic management of pod borer, *Helicoverpa armigera* infesting chickpea:

- Installation of bird perches with 100 per hectare two weeks after germination.
- Spraying of neem seed kernel suspension with 5 percent (500 g of seed kernel in 10 litres of water) when first Instar larvae are observed.
- Dusting of methyl parathion by 2 percent dust with 25 kg per hectare at the time of pod formation on 50% plants.

Spray 5 percent leaf extract of Naffatia (Nalo), Ipomea carnea or Ardushi Adhatoda vasica leaf extract 5 percent three times (Add sticker with 1 ml per litre of spray fluid). First spray at vegetative stage, second at flowering on 50 percent plants and third at pod formation on remaining 50 percent plants rose under conserved soil moisture.

Dillseed

Variety of dillseed Gujarat Dillseed- 2 is released for *rainfed* farming.

Crop geometry of 75 cm x 30 cm with plant population of 0.44 lakh per hectare is optimum for dillseed under conserved moisture condition.

Sowing of dillseed by applying one irrigation of 50 mm after 30 days after sowing fertilized with 20 kg Nitrogen per hectare and 20 kg potassium per hectare as basal application and 20 kg Nitrogen per hectare as top dressing after irrigation to secure higher yield and better returns. While, under conserved moisture condition, farmers should apply only 40 kg Nitrogen per hectare as basal application at the time of sowing.

Mustard

A period between 10th to 20th October is optimum sowing time for mustard cv. Varuna. In case, the maximum temperature around 10th October is found more than 35⁰ C, sowing should be done around 20th October.

Crop geometry of 90 cm x 15 cm with plant population of 0.74 lakh per hectare is optimum for under conserved moisture condition.

Irrigating mustard cv. Varuna at 30 days after sowing found to be more economical than irrigating at 50 percent flowering.

One irrigation of 50 mm from harvested rain water at 30 days after sowing increases seed yield by 34.06 percent.

Application of 60-0-0 NPK kg per hectare at sowing is economical dose under conserved moisture condition. However, under limited irrigation condition, crop should be fertilized with 60-20-0 NPK kg per hectare.

Application of 1 ton Gypsum per hectare before onset of monsoon increased seed yield by 11.03 percent.

Safflower

Bhima variety is identified for *rainfed* farming in *Bhal* and Coastal Agro-climatic Zone.

Package of practices should be adopted for getting higher seed yield. Among the various inputs, plant protection is the most important followed by fertilizer. Thinning and weed control are of minor importance in *Bhal* region in terms of their contribution to seed yield.

Crop geometry of 90 cm x 15 cm with plant population of 0.74 lakh per hectare is optimum for varieties Bhima and A- 2 under conserved moisture condition.

Safflower responded to nitrogen up to 25 kg Nitrogen per hectare under conserved moisture condition. It did not respond to applied phosphorus.

Application of sulphur with 30 kg per hectare through ammonium sulphate or gypsum or single super phosphate increases seed yield.

Cycocel spray with 500 ppm at flower initiation or 50 percent flowering stage is more productive and remunerative.

Seed inoculation with Azospirillum + Azotobacter helped to save nitrogen fertilization up to 50 percent.

Cotton

Sowing should be taken up immediately after onset of monsoon. In any case it should not be delayed beyond first week of August. Further delay in sowing tended to reduce yield.

An inter row spacing ranging from 120 cm to 200 cm for *rainfed* cotton should be followed depending upon the availability of bullock or tractor drawn implements. Wider spacing not only involves low cost but also proved suitable for aftercare operations like weeding, interculturing and spraying of insecticides.

Although use of black plastic (50 micron) increased the yield by 26 percent, not found economically viable with the present cost of plastic.

Spraying of Kaolin to cotton cv. G.Cot.- 13 at 50 percent flowering and boll formation stages did not show significant effect on seed cotton yield in agro- ecological situation.

Application of two irrigations each of 6 cm depth at 20 and 42 days after cessation of monsoon (75% ASMD) increased seed cotton yield by 65 percent. Farm waste compost with 10 tons per hectare should be incorporated in rows before sowing. Nitrogen with 40 kg per hectare is recommended.

Apply potassium with 20 kg Potassium per hectare at 6 cm soil depth adjacent to cotton row after withdrawal of monsoon for getting higher yield and higher net income.

Apply two irrigations, each of 60 mm at 20 and 40 days after withdrawal of monsoon to deshi (G. Cot.- 13, G. Cot.- 21) and hybrid (Hy.- 6, Hy.- 8 and Hy.- 10) for higher seed cotton yield.

Castor

25 kg Nitrogen per hectare is recommended for *rainfed* castor.

Fodder sorghum

Apply fertilizer with 15:15:0 NPK kg per hectare at the time of sowing of fodder sorghum cv. Trapaj for optimum fodder yield.

Hybrid fodder sorghum GFSH-1 should be fertilized with 40 kg Nitrogen per hectare and 10 kg Potassium per hectare for doubling yield in soils having low Nitrogen and Potassium status.

Fodder sorghum cv. Solapuri under conserved moisture condition during *rabi* season, are advise to apply 30 kg Nitrogen + 15 kg Potassium per hectare for getting higher yield and economics.

Sowing *kharif* sorghum cv. SSG 59 3 with cowpea cv. GFC 3 intercropped in 2:1 row ratio and fertilized with 40 kg Nitrogen per hectare and 15 kg Potassium per hectare to secure higher forage yield with good quality and higher returns.

Sowing of sorghum cv. SSG 59 3 should be carried upto 30th October to obtain higher green forage and dry fodder yield and better returns under conserved moisture condition in *Rabi* season. In case of delayed sowing condition, cv. Maldandi- 53 should be preferred.

Pigeonpea

Inter row spacing of 60 cm or 75 cm should be followed for higher seed yield.

Paddy

Application of 10 tones Farm Yard Manure + 150 kg Nitrogen per hectare is recommended for transplanted paddy cv. SLR- 51214.

Grasses

Gatton panic and Dichanthium grasses are found suitable for marginal land of *Bhal* and Coastal Agro-climatic Zone.

Crop geometry of 45 cm x 30 cm or 30 cm x 30 cm is found optimum for Gatton panic grass. For maximizing forage yield, grass needs to be fertilized with 75 kg Nitrogen per hectare every year.

Irrigations with saline water (upto 8 ds/m) to Gatton panic and Dichanthium sustain the production to meet forage needs in drought years.

Weed management

Spray Glyphosate with 0.4 percent + 1.5 percent Ammonium Sulphate for effective control of camel thorn. As this herbicide is nonselective in nature, it should be applied after harvest of wheat crop.

Agricultural Engineering

The depth of dugout pond should be kept 1.5 meters for minimizing the loss of stored water. LDPE sheet (100 micron) can be used as a lining material in dugout pond to reduce further seepage loss of stored water.

Bullock drawn automatic seed cum fertilizer drill is designed, tested and recommended for *Bhal* and Coastal Agro-climatic Zone for uniform placement of wheat and gram seeds with fertilizer.

Agro-forestry and Horticulture

Growing of *Prosopis juliflora* in salt affected soils for 6 to 7 years reduces total salt concentration (EC 2.5) from 0.95 to 0.38 ds/m and ESP from 24.5 to 6.7 with increase in the infiltration rate from 0.25 to 0.53 cm per hectare.

Among different arid fruits, ber cv. Gola found most economical under *rainfed* conditions of *Bhal* and Coastal Agro climatic Zone. Crop should be fertilized with 500 g castor cake and 50 g DAP per pit before planting and 50 g DAP and 75 g Urea every subsequent year.

For improving saline-sodic/waste land of *Bhal* and Coastal Agro climatic Zone to cultivable land, grow forest species like *Prosopis juliflora* or *Acacia tortilis* or *Azadirachta indica* for a period of 6 to 7 years. Forest tree species like, *Eucalyptus* hybrid, *Tecomella undulata*, *Casurina* spp. are next in order whereas forest tree species like *Albizia lebbek*, *Moringa olifera*, *Sesbania egyptica* and *Atriplex halimus* have shown very low to no adaptability.

Ber cv. Gola grown in poor land under *rainfed* situation, are advised to adopt surface mulching techniques just after cessation of monsoon with wheat husk (Dantha) spreading around plant up to 2 meters with thickness of 5 cm for securing higher yield and higher additional income.

Land configuration

Land configuration involving raised (15 cm above surface) and sunken (15 cm below surface) bed system of cultivation should be adopt for substantial yield of *kharif* and *rabi* crops. Cotton should be grown on raised bed during *kharif* and wheat or gram in sunken bed during *rabi* for securing higher income.

Fertilizer management In Crop Rotations

The farmers of *Bhal* and Coastal Agroclimatic Zone following safflower - fodder sorghum rotation are advised to inoculate seed of both the crops with PSB (*Pseudomonas striata*) in order to save half the dose of phosphorus.

Contingent planning

Under normal monsoon (June- July), farmers of *Bhal* and Coastal Agroclimatic Zone should prefer cotton, whereas under delayed monsoon (After July) fodder sorghum gives better returns.

Limited irrigation

Farmers of *Bhal* and Coastal Zone growing *rabi* crops under conserved moisture or under supplementary irrigation are advised to put their first preference to wheat crop, followed by chickpea and dillseed for getting higher seed yield and higher income. In case of availability of good quality water irrigate crop up to twice (50 mm each) for getting higher yield and income without affecting the soil health.

Pitcher irrigation in bottle gourd

Farmers of *Bhal* and Coastal Agro-climatic Zone are advised to adopt pitcher irrigation method for growing bottle gourd, especially where water is saline. The pitcher should be replaced once in 4 years.

Achievement (Research recommendations for the farmers) & Publication