Technical Bulletin

Technologies to Enhance Groundnut Productivity

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Preface

India is amongst the largest producer and consumer of vegetable oils in the World. Oilseeds have been the backbone of agricultural economy of India since long. Indian vegetable oil economy is the fourth largest in the world next to USA, China and Brazil. Oilseed crops play the second important role in the Indian agricultural economy next to food grains in terms of area and production. The Indian climate is suitable for the cultivation of oilseed crops; therefore, large varieties of oilseeds are cultivated here. The major oilseeds cultivated in our country are soybean,rapeseed and mustard,groundnut sunflower, castor, sesame, niger, safflower and linseed. However, soybean,rapeseed and mustard,groundnut and sunflower account for a major chunk of the output. Among oilseeds, groundnut is one of the most important oilseed crops and occupies an area of 21.5% and production of 25.4% out of the total area and production of oilseed crops with an average productivity of 1411 kg/ha in India which is quite low as compared to USA and China. The low and fluctuating productivity is primarily because cultivation of groundnut is mostly done on marginal lands, which are lacking in irrigation and low levels of inputs are used here. Therefore, there is an urgent need to improve the productivity of groundnut with the adoption of improved technologies.

Looking to the need of farmers, this publication entitled "Technologies to Enhance Groundnut Productivity"provides an overview of different technologies to be adopted to enhance the productivity of groundnut Data and photographs in this bulletin have been taken from the published articles, reports of All India Coordinated Research Project on Groundnut, training manuals and various bulletins.

We are thankful to staff members of Directorate of Groundnut Research, Junagadh for rendering possible help and cooperation in facilitating the preparation of this bulletin.

We shall consider our effort fruitful if this technical bulletin serves the purpose for which it is intended and proves ultimately helpful to farmers and field extension functionaries providing technical base for groundnut production.

We are aware of the possibility of shortcomings and defects in this technical bulletin. We shall appreciate if the readers could bear with them and communicate the same to us so that we can bring out a better edition next time.

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Introduction

In India, groundnut is one of the most important oilseed crops and occupies an area of 5.86 m ha with production and productivity of 8.26 m tonnes and 1411 kg/ha, respectively (2010-11). The main groundnut growing states are Gujarat, Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka and Rajasthan. It is also known as peanut, monkeynut or moongfali. Botanical name of groundnut is *Arachishypogaea* which is derived from Greek word *Arachis* means legume and *hypogaea* means below ground, referring to formation of pods in the soil. Groundnut plays an important role in the dietary requirement of resource poor woman and children. Groundnut kernels are also used for the preparation of food products like chikkis, groundnut milk, butter, curd including different bakery products. Groundnut cake obtained after extraction of oil, is used as valuable organic manure and feeding material for livestock. It consists of 7.3% N, 1.5% P_2O_5 and 1.3% K_2O. The peanut haulms contain crude protein 8–5%, lipids 1–3% and minerals 9–10%. These are used as cattle feed either in fresh or in dried stage or preparing hay or silage. The peanut shells or pod walls which constitute nearly about 25% of total pod weight are used as bedding material for poultry or as mulching material during summer season to reduce the evaporative losses. Shell material is also used as filler material for making mixed fertilizers and as insulation material for buildings or as fuel in boilers.

Average nutritive value of groundnut (per 100 g kernels)

Carbohydrate (g)	26.1	Ca (mg)	90
Protein (g)	25.3	Niacin (mg)	19.9
Fat (g)	40.1	Fe (mg)	2.5
Minerals (g)	2.4	Thiamine (mg)	0.90
Moisture (g)	3.0	Riboflavin (mg)	0.13
Fiber (g)	3.1	Carotene (µg)	37
P (mg)	350	Energy (Kcal)	567

Source:Gopalan,C., Ramasastry,B.V., Balasubramanian, S.C., Narasingarao, B.S., Deosthale,Y.G. and Pant, K.C.1971. Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad.

Soil and field preparation

Groundnut can be grown on all types of soils such as sandy, sandy loam and heavy black soils. Most suitable soils for groundnut production are well-drained, light-textured, loose sandy-loam or sandy clay loam soils with good drainage, having reasonable high calcium, pH 5.5 to 7.0 and a moderate organic matter. The ill drained acidic (pH <5.5), alkaline (pH >7.8) and saline soils are not suitable for groundnut production. Soils having pH less than 5.5, need to be corrected by furrow application of lime @ 2 t/ha.

Field preparation for groundnut depends on the soil type and onset of monsoon for rainfed crops and the previous crops grown for irrigated crop. The soils are usually ploughed twice with the summer rains or after application of irrigation water for winter/summer sowing followed by two to three harrowings and pulverizing well to obtain a good tilth for optimum germination. Optimum depth of ploughing is 15 -20 cm. If too deep ploughing is done, it leads to development of pods in deeper layers which makes the harvesting difficult. Summer ploughing is advantageous to kill weed seeds and hibernating insects and diseases organisms by exposing them to the heat of summer. In terrace and flat lands of high rainfall areas, raised beds of 10-15 cm height are to be prepared to avoid water-logging problems.

Seed quality and treatment

Groundnut pods for seed purpose are shelled either by hand or by using hand decorticator about a week in advance of sowing. The viability of seed will be lost if shelled long before seeding. After and during the shelling split or damaged, shriveled immature and infected seeds should be removed and only well-filled seed should be used for sowing. The seed must be tested for their germination and should be treated with mancozeb or carbendazim @ 2-3g/kg kernel to control seed borne diseases. The seed can also be treated with *Trichodermaviride* @ 10 g/kg seed or it can be applied @ 10 kg/ha as soil application. To prevent the seed damage from soil insects at initial stages, depending upon per cent infestation chloropyriphos @ 12.5-25 ml/kg seed can be used. Spreading and semi-spreading types groundnut varieties have dormant seeds just after harvest which usually require a resting period of 60-70 days. Dormancy can be broken by exposing seeds to ethrel solution of 250 ppm. Bunch type varieties can be used immediately after harvesting for sowing. Thereafter, the kernels should also be treated with suitable *Rhizobium* and PSB cultures (3 packets of each).

Sowing time and sowing

In India, groundnut is mainly grown in during *kharif, rabi* and summer seasons.

Kharif groundnut is sown from June to November mostly in the states of Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Madhya Pradesh and Uttar Pradesh.

Rabi groundnut is grown from November to April mostly in central, eastern and southern parts of the country. It is mostly grown in rice fallow situations under residual moisture conditions or with limited irrigation facility and in river-bed fields of Orissa, Assam and West Bengal.

Groundnut is also grown as irrigated crop during January to May/June as summer crop mostly in Gujarat, Maharashtra and some parts of Andhra Pradesh, Karnataka, Tamil Nadu and Rajasthan.

The groundnut is generally sown in flat beds. Some of the improved methods to get higher yield over the conventional method are given below:

1. Criss-cross sowing

Criss-cross method can improve yield by about 18% as compared to conventional sowing by maintaining uniform distribution of seed and optimum number of plants/unit area. The seed rate used in this method is same as in conventional method. In this method, total seed lot is divided into two equal halves; first half of the seed is sown in one direction adopting 30 cm spacing between rows and then the remaining half in the perpendicular direction with the same spacing.	

2. Broad-bed and furrow method (BBF)

BBF method is useful in areas having deep vertisol with high rainfall. This system consists of raised beds of 1.2 m width and 15 cm height with two furrows of 30 cm width on either side. Each raised bed would accommodate four rows with 30 cm spacing between rows. On an average, 15% higher yield of groundnut has been reported from the medium black soil over the flat bed.	

3. Ridge and furrow method

Groundnut is generally sown on flat beds using a seed drill but sowing on either sides of the ridge helps the plants to prevent from come in direct contact with the excess water. Furrows are more advantageous as they increase moisture recharge in the soil by colleting water and simultaneously help in draining away excess water.	

Recommended varieties

Recently released varieties for different states:

State	Recommended groundnut varieties
Andhra Pradesh	Kadiri-5, Kadiri-6, Kadiri-7, Kadiri-8, Kadiri-9, Kalahasti, Narayani, Prasuna, Abhaya, Greeshma, Vijetha, ICGV-00350
Gujarat	GG-6, GG-7,GG-16,GG-20, TG-26, GJG-HPS-1, Prutha, JL-501, TG 37 A
Maharashtra	TKG-19A, TLG-45, PhuleUnap, Ratneshswar, AK-265, AK-303, TAG-24
Tamil Nadu	TMV-13, VRI-6, VRI-7, AK-265, Ajeya, ICGV-00348, ICGV-00350, Vijetha, GG-16
Karnataka	AK-265, Ajeya, ICGV-00348, ICGV-91114, VRI-6, VRI-7, GG-16, TGLPS-3, Vikas, KadiriHaritandhra
Rajasthan	HNG-10, HNG-69, HNG-123, GG-7, GG-20, TBG-39, TG 37 A, TAG-24, Girnar-2, PM-1, PM-2, Prataprajmoongphali, Durga
Madhya Pradesh	JGN-3, JGN-23, AK-159, GG-8
Haryana	ICGS-1, MH-4, Prakash, HNG-10, Mukta
Punjab	SG-99, M-548, TG 37 A, GG-21, Girnar-2, HNG-10, HNG-69
Odisha	Smruti, ICGV-91114, TG-51, Vijetha, Girnar-3, TG –38 B, Vasundhara, TG-37 A, Devi

West Bengal	TG-51, Vijetha, Girnar-3, TG–38 B, Vasundhara, TG-37 A
Uttar Pradesh	TG 37 A, GG-21, Girnar-2, HNG-10, HNG-69, Prakash, Utkarsh
NEH region	TG-51, Vijetha, Girnar-3, TG–38B, Vasundhara, GPBD-5
Jharkhand	Girnar-3

Spacing and seed rate

Inadequate crop stand is one of the major factors limiting the productivity of groundnut. Optimum plant population depends on plant type (bunch or spreading), soil, moisture and management practices. Higher plant population reduces the number of branches per plant while lower plant population increases the number of branches/plant. Number of pods/plant increases with increase in number of branches/plant. Seed rate depends upon the size of kernels, test weight (100-kernel weight), inter-and- intra-row spacing. The usual seed requirement of bunch type groundnut is 100-110 kg/ha while a seed rate of 95-100 kg/ha for semi-spreading and spreading varieties is adequate. The most common spacing recommended for bunch type varieties is 30 cm x 10 cm to achieve a plant population of 3.33 lakh/ha. For runner type, the most common spacing recommended is 45 cm x 10 cm or 30 cm x 15 cm to achieve a plant population of 2.22 lakh/ha in rabi/summer groundnut.

Cropping systems

Crop sequences: In general, groundnut should be rotated with cereals like pearl millet, sorghum, maize, wheat, rice or other minor millets. This will check the build up of pests, white grubs, nematodes, soil borne diseases, leaf spots and also maintain soil fertility. Some of the promising crop sequences recommended for different states are given in table 1

Table 1. Promising crop sequences recommended for different states involving groundnut

State	Rainfed (Monocropping)- two years	Residual moisture (Double cropping in one year)	Irrigated (Double or triple cropping in one year
Andhra Pradesh	Groundnut-sorghum	Groundnut-bengal gram	Groundnut-maize
	Groundnut-millet	Groundnut-safflower	Groundnut-wheat
	Groundnut-tobacco	Groundnut-sesame	Groundnut-onion
Gujarat	Groundnut-sesame	Groundnut-fodder sorghum	Groundnut-mustard-green gram
		Groundnut-mustard	Groundnut-wheat-green gram
Karnataka	Groundnut-sorghum	Groundnut-safflower	Groundnut-wheat
			Groundnut-maize
			Groundnut-sunflower
Maharashtra	Groundnut-sorghum	Groundnut-safflower	Rice-potato-groundnut
		Groundnut-fodder maize	Groundnut-*rabi*sorghum
			Groundnut-safflower
Tamil Nadu	Groundnut-sesame	Groundnut-sesame	Rice-rice- groundnut
	Groundnut-cotton		Groundnut-rice-green gram
			Groundnut-maize
Rajasthan	Groundnut-pearl millet	Groundnut-barley	Groundnut-wheat-green gram
		Groundnut-mustard	Groundnut-wheat
Madhya Pradesh	Groundnut-sorghum	Groundnut-safflower	Groundnut-wheat/ mustard
Orissa	Groundnut-sorghum/pearl millet	Groundnut-bengal gram	Groundnut-rice/ragi
		Groundnut-sesame	Groundnut-coriander/cumin

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Intercropping: The most important cereal intercrops grown with groundnut are bajra, sorghum and maize. The other long duration crops suitable for intercropping with groundnut are red gram, cotton, castor, cassava while short duration crops are sesame, sunflower, cowpea, green gram and black gram. Intercropping systems suggested for different states are presented in table 2 along their proportions with the groundnut as base crop.

Table 2.Some intercropping systems in different states.

State	Intercropping system	Ratio to base crop (groundnut)
Andhra Pradesh	Groundnut + pearl millet	3 : 1
	Groundnut + cowpea	6 : 1
	Groundnut + red gram	6 :1 or 8 : 1 or 10 : 2
	Groundnut + castor	5 : 1 or 7 : 1
Gujarat	Groundnut + sesame	1 : 1
	Groundnut + sunflower	1 : 1
	Groundnut + red gram	3 :1
	Groundnut + castor	1 : 1
Karnataka	Groundnut + red gram	4 : 1
	Groundnut + cotton	3 : 1 or 5 : 1
	Groundnut + sorghum/ragi	6 : 1
Maharashtra	Groundnut + sorghum	4 : 1 or 6 : 2
	Groundnut + red gram	6 : 1 or 10 : 2
Madhya Pradesh	Groundnut + red gram	8 : 2 or 10 : 2
	Groundnut + soybean	4 : 1 or 6 : 1
	Groundnut + sesame	4 : 1
Tamil Nadu	Groundnut + black gram/green gram	6 : 1
	Groundnut + cotton	5: 1
	Groundnut + castor	7 : 1
	Groundnut + sesame	6 : 1
Rajasthan	Groundnut + pearl millet	4 : 1
	Groundnut + sesame	4 : 1

Manures and fertilizers

For every one ton of pods and 2 tonnes of haulms produced by the groundnut crop, about 63 kg N, 11 kg P_2O_5, 46 kg K_2O, 27 kg CaO and 14 kg MgO is removed from 1 ha land. Groundnut, beings a leguminous crop, is capable of fixing atmospheric nitrogen by the root nodule bacteria. Application of nitrogenous fertilizers is not required but lower does of nitrogen would be sufficient to raise a good crop. In general, for obtaining high yield of groundnut application of well decomposed farmyard manure @ 10 t/ha at least 21 days before sowing followed by recommended doses of NPK (table 3) through urea, single super phosphate and muriate of potash, respectively is recommended depending upon the initial soil fertility status and nature of crop. For a rainfed crop, entire doses of nitrogen, phosphorus and potassium should be applied by placement at seeding in the furrow below the seed at sowing. For an irrigated crop, nitrogen may be applied in two equal splits at sowing and 30 days after sowing. Acid soils are deficient in Ca, S and Mg. To set good yield, the availability of Ca in the fruiting zone must exceed a defined critical level during the time of pod development. Soil application of 250 kg/ha gypsum is sufficient to overcome the deficiency of Ca and S and increase the pod yield. Soil application of 10 kg Mg/ha as $MgSO_4$ corrects Mg deficiency.

Table 3. Recommended doses of NPK for different states

State	Situation	N-	P -	K (kg/ha)
Andhra Pradesh	Rainfed	20	40	20
	Irrigated	30	60	45
Gujarat	Rainfed	12.5-25	25-60	0
	Irrigated	25-37.5	50-70	0
Karnataka	Rainfed	15	30	25
	Irrigated	25	75	25
Madhya Pradesh	Rainfed	20	40	20
Punjab	Irrigated	15	40	25
Rajasthan	Rainfed	20	60	0
	Irrigated	20	60	0
Maharashtra	Irrigated	20	40	0
Uttar Pradesh	Rainfed	15	30	45
West Bengal	Irrigated	15	30	45
Tamil Nadu	Rainfed	11	22	33
	Irrigated	22	44	66

(Source: Desai, P.M., Kotecha, P.M. and Salunkhe (1999). Science and Technology of Groundnut: Biology, Production, Processing and Utilization (chapter 9),First edition, NayaProkash, Calcutta, P. 254

Groundnut crop grown with recommended dose of fertilizers

Correction of micronutrient deficiencies

A schedule for correcting micronutrient deficiency is given in the table 4 below:

Table 4. Schedule for controlling micronutrient deficiencies

Micronutrient	Form and rate of allocation to soil	Spray schedule
Boron	Borax 5-20 kg/ha	0.2% borax
Copper	Copper sulphate 5-10 kg/ha	0.1% copper sulphate + 0.05% lime
Manganese	Manganese sulphate 10-50 kg/ha	0.6% manganese sulphate +0.3% lime
Zinc	Zinc sulphate 10-50 kg/ha	0.5% zinc sulphate + 0.2 % lime
Molybdenum	Sodium or ammonium molybdate 0.5-1.0 kg/ha	0.01% ammonium molybdate
Iron	Ferrous sulphate 10 kg/ha	0.5% ferrous sulphate+ 0.02% citric acid

Weed management

Weeds cause much damage to the groundnut crop during the first 35 days of its growth. The most critical period of weed competition is from 3-6 weeks after sowing. The average yield loss due to weeds is about 45%. When once pegging begins (40 DAS), there should not be any disturbance to pegs through manual or mechanical weeding. Important weed flora in the groundnut crop are listed below:

Amaranthusviridis (JangliChaulai)
Boerhaaviadiffusa (Vishakhapra)
Cyperusrotundus (Motha)
Cyperusesculentus (Yellow nut sedge)
Cynodondactylon(Doob grass)
Digeraarvensis (Laksha)
Convolvulus arvensis (Hirankhuri)
Argemonemaxicana (Satyanashi)
Anagallisarvensis (Krishna neel)
Desmodiumtrifolium (Tinpatia)
Commelinabenghalensis(Kankawa)
Celosia argentea (White cock's comb)
Portulacaoleracea (Pig weed)

Management

- A good crop cover by adopting right spacing between rows and within the row will smother the weed growth.
- Mulching the soil surface in between rows with crop residue material like straw etc may prevent the germination of weed seeds and at the same time smothers the established young weeds.
- Adopting proper crop rotation practices will help in overcoming the dominance of certain weeds and lessening the weed competition in groundnut crop.
- Intercropping practice in groundnut crop not only provide the monetary and land utilization advantages but also help in smothering the weeds with good crop cover over the land surface.
- Hand pulling of weeds though primitive is an efficient way of controlling weeds especially in groundnut.

- Hand weeding is done twice, first around 20 days after sowing and second at about 35 days after sowing.

- Intercultivation usually starts around 10 days after emergence and continues up to 35 DAS at 7– 10 days interval till pegging begins.

- Cost effective weed management under rainfed conditions is repeated inter-cultivation (harrowing) up to 35 days after sowing followed by hand weeding.
- Herbicides can also be recommended for use in groundnut:

Herbicide	Rate of application (kg a.i./ha)	Time of application
Pendimethalin	1.0-2.0	Pre-emergence
Oxyfluorfen	0.25-0.50	-do--
Quizalofop ethyl	0.050	Post-emergence
Imazethapyr	0.050	-do-

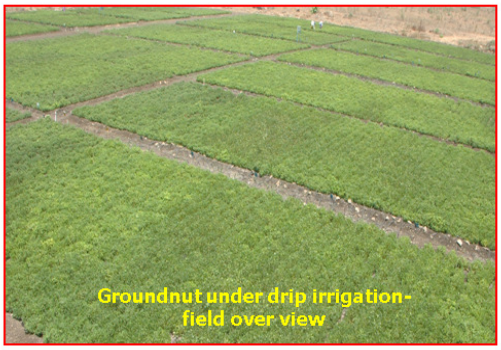
- Integrated weed management involving the above two appears most effective and economical, provided the crop is not subjected to prolonged drought or soil moisture stress during the crop period.

Water management

Groundnut crop is mostly cultivated during *kharif* under rainfed conditions. Irrigated groundnut accounts for over 20% of the total area under the crop in the country and it yields around 4.2 t/ha.

- There is no necessity for irrigation or rainfall up to 25 days after emergence of groundnut.
- Flowering (20-40 DAS), pod formation and development (40-70 DAS) and pod filling and maturation (70-100 DAS) are most sensitive to soil moisture stress.

- Scheduling irrigation at 25% DASM during moisture sensitive stages and at 50% DASM during other stages results in high pod yield and water use efficiency.
- An IW/CPE ratio of 1.0 at moisture sensitive stages and 0.6 during other stages leads to high water use efficiency.
- If irrigation water is not limiting, then a total of 8 irrigations are adequate for optimal yield i.e. pre–sowing irrigation followed by an irrigation at 25 DAS, 4 irrigations at 10 days interval and final two irrigations at 15 days interval.
- At times of deficit supplies, an irrigation at 25 DAS followed by 2 at 15 days interval between 45 and 75 DAS appears to be minimum requirement and it can minimize yield losses due to soil moisture stress. The first irrigation is given at 25 DAS to create moisture stress in the soil which is desirable:
    - to get the good root system.
    - to reduce excessive vegetative growth.
    - encourage the better nodulation
    - induce heavy flowering in a single flush (synchronous flowering)
- Keeping the total quantity of irrigation water applied constant, high frequency irrigation increase the pod field of groundnut on sandy and sandy loam soils.
- Depending on soil type, evapotranspiration and crop duration, water requirement of groundnut ranges between 450 and 650 mm.
- The crop is usually irrigated by check basin method. Border strip is more suitable than other methods. Sprinkler irrigation is ideal for g. nut crop on sandy soils.
- Recently drip irrigation is becoming popular among groundnut growers as it increases crop yield by 25-40% besides better seed quality and saves up to 40-50% irrigation water compared to flood irrigation.



Harvesting, drying and storage

As groundnut is an indeterminate crop, hence synchronous maturity of its pods can not be obtained. Therefore, harvesting should be done when 75-80% of pods are fully mature. The important indications of maturity are yellowing of foliage, necrotic spotting of leaves, dropping of old leaves, pods become very hard and tough, they give cracking sound when split open with fingers, the inside of the shell turning dark, with netted venation, seed coat develops pink or red colour (normal colour of the varieties) and raising of the soil to the base of the stem is observed. Generally harvesting is done by pulling or lifting the plants from the soil with pods intact. If soil moisture is adequate, then hand pulling. If soil is dry, tractor or bullock drawn blades are used for lifting the vines with pods. Harvesting before maturity reduces yield and oil percentage and seeds are highly susceptible to aflatoxin. If delayed, results in increased incidence of stem rot, weakening of

gynophore/peduncle and some of the pods may remain in soil itself at the time of harvesting.

Different maturity stages of groundnut

The most common method is stripping pods with hand. At the time of harvest, pods usually have moisture content around 40–50% and hence need to be dried to 10% moisture content for safe storage. Drying should be done rapidly to prevent fungal infection. Sun drying is the usual method of drying. Summer groundnut should be dried in shade to prevent loss of viability, if it is for seed purpose.

Storage at farmer level is invariably in the form of pods. Farmers usually dispose of groundnut pods within a month from drying yard itself. A few store it for 6 months (till kharif seeding) in anticipation of high price. Pods for seed purpose are stored for 7–8 months. Pods for seed purpose are stored in earthern pots, mud bins or bamboo baskets or Gunny bags having polythene lining.

If the seed moisture content is above the critical level of 9-10%, then aflatoxin production due to *Aspergillusflavus* just before the post–harvest drying and mould growth at later stage takes place.