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BARANI AREA SUNFLOWER PRODUCTION TRAINING MANUAL

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Introduction

Sunflower production research data is currently inadequate to formulate detailed recommendations for specific Barani areas. Consequently the information and general recommendations contained in this manual will have to suffice until additional production knowledge is gained through research and experience. Each agricultural official and farmer can contribute to the accumulation of such knowledge by accurately recording and reporting his sunflower production experiences. You are therefore kindly requested to take accurate notes of your observations and results and the conditions of the location in which your notes were collected and send them to the Barani Project Director, 175 Aibak Road, Westridge-I, Rawalpindi.

Sunflower Adaptation

Sunflower thrives wherever maize is grown, but may also be grown successfully at high altitudes that are too cold for maize and it will tolerate as much drought as sorghum. The crop is far more tolerant of low soil fertility than maize and is fairly salt tolerant. Sunflowers have a very well developed tap root system that can penetrate to a depth of (3 metres) 9, 9 feet. They are also fairly resistant to both heat and cold. The young plants are even resistant to freezing temperatures. This resistance is gradually lost until by the six-to-eight leaf stage, temperatures slightly below freezing may cause injury.

Moisture stress most seriously reduces yield if it occurs during the 3 week interval from heading to flower completion, because moisture stress during this time often stops flower development.

During extreme moisture stress you will see stalks break from 6 to 24 inches above the ground at heading time. This appears to be nature's way of thinning the population. Sunflowers also withstand intensive rainfall very well.

Planting Dates

Rainfall distribution and planting date will strongly determine product on in the Barani areas of Punjab, Pakistan.

A spring crop can be planted in February or early March and harvested in May-June. The Kharif crop can be sown in early July and August, and harvested in October-November.

Rainfall distributions shown in table No. 1 illustrate the possibility of successful sunflower production in several areas.

Table 1

Rainfall Distribution Average for 1965-70

Location	Feb.	Mar.	Apr.	May	Total	July	Aug.	Sep.	Oct.	Total
Rawalpindi	2.55	3.24	1.15	0.87	7.81	6.61	12.53	2.17	1.36	22.60
Jhelum	1.94	2.47	1.35	1.25	7.01	5.96	7.35	1.83	1.43	16.58
Gujrat	1.07	1.23	0.80	0.93	4.03	5.63	8.03	3.15	0.24	17.00
Campbellpur	1.31	1.24	1.15	0.63	4.33	2.66	7.48	1.36	0.53	12.00

The little information collected on planting dates reveal that the spring crop is best planted in early February to prevent the 3-week drought sensitive period of sunflowers from occurring during the May dry period. Likewise the earlier in July the Kharif crop is planted the better the chances of preventing the September dry spell from occuring during the 3-week drought sensitive period prior to flower competition.

Planting Depth

Remember that sunflower takes longer to emerge than most grain crops because of the slow penetration of soil moisture through the thick hulls. Seedlings will emerge from depths of 3 inches or more but a much better stand is obtained from a 1-inch depth planting.

Despite the advantages of planting 1-inch deep it must often be 1-1/2 to 2 inches because of dry surface soil conditions or in sandy soils. Shallow planting on sandy soils may result in the soil drying before the seed absorbs enough water thus delaying germination until the next rain.

Row Width and Plant Population

The seedbed should be similar to that prepared for maize except that deeper initial tillage may be more of an advantage for the deep rooted sunflowers. The general recommendation for row to row spacing is 2 ft. (60 cm); for plant to plant spacing 8 to 10 inches (20 to 25 cm). This will result in 32,000 to 26,000 plants per acre, respectively.

Sunflowers tend to lodge when sown in 6 to 12 inch row spacing and weed control is very difficult. A seed rate of 5 to 10 lbs. per acre will be adequate depending on the percent germination, the number of seeds per lb., and the soil type.

You may use table No. 2 as a guide in determining the best seed rate when your seed has 100% germination.

Table No. 2

Guide to Seed Rate Per Acre Based on Seed, Weight and desired Population

Weights/grams)/100 Seeds	15.1	11.3	9.1	7.6	6.5	5.7	5.0	4.5	4.1
Number of Seeds/lb.	3000	4000	5000	6000	7000	8000	9000	10000	11000
Desired Population	Seed (pounds) Required for Acre								
15000	5.0	3.8	3.0	2.5	2.1	1.9	1.7	1.5	1.4
20000	6.7	5.0	4.0	3.3	2.9	2.5	2.2	2.0	1.8
25000	8.3	6.3	5.0	4.2	3.6	3.1	2.8	2.5	2.3
30000	10.0	7.5	6.0	5.0	4.3	3.8	3.3	3.0	2.7
35000	11.7	8.8	7.0	5.8	5.0	4.4	3.9	3.5	3.2

It might be best to increase the seed rate by 10% on sandy soils and by 20% on soils that tend to crust.

If your seed has less than 100% germination use the following formulae to calculate the seed rate increase:—

$$\frac{\text{lb./acre} \times 100}{\%\ \text{of Germination}}$$

For example: say you desire a population of 30,000 plants/acre and your seed weighs 7.6 gm/100 seeds. According to table No. 2 you will use a 5 lb./acre seed rate if your seed = 100% germination. I. your seed only has 85% germination you will need $\frac{5 \times 100}{85}$ = 5.9 lb./acre. Then if you plan to plant on soils that tend to crust badly, you will need 5.9 lb. ×20% = 1.2 lb./acre more, or 7.1 lb./acre seed rate.

Actually sunflowers will yield well through a wide range of populations. They adjust to low populations by increasing head and seed size and to excessive populations by decreasing head and seed) size. Therefore it may be best to plant non-oil, human food (confectionary varieties at a bit lower rate to obtain large seed size. Even a 5000-plant per acre reduction in population may not appreciably affect yield but will significantly increase seed size. For oil-seed production, the objective is to get maximum yield with no regard for seed size. Medium to high populations will produce seed of higher oil percentage than low populations. The ideal population for each variety will be determined through experience in your area. This is another reason for taking good notes of your observations.

Keep in mind that short season varieties generally require less space per plant than long season varieties so it is best to use a little higher seed rate when planting them.

Uneven stands are a major cause of yield reduction and plant spacing, in the best of sunflower fields, is usually less uniform than in corn fields. Therefore you need to be more careful in planting sunflowers to obtain a uniform stand.

Another problem is weak and diseased plants that don't utilize the space available. Non-hybrid varieties have a larger number of inbred or low yielding plants than hybrid varieties. These plants provide competition to neighbouring plants but contribute little to seed yield. Hybrid varieties will reduce this weak plant problem.

Rember that high populations offer the advantage of small heads that dry faster than large heads but high populations usually lodge more than low populations.

Seed Treatment

A fungicide seed treatment will help control seed-borne disease organisms and may increase the stand. Sunflower seed is tolerant of most fungicides but overdoses can cause injury. Additional research is required before good recommendations can be made on seed treatments.

Crop Sequence and Rotation

Three major considerations in determining crop sequence are: 1. Control of volunteer sunflowers, 2. Control of diseases, and 3. Effect of sunflowers on the following crop :

1. *Volunteer Sunflowers.* Before and and during harvest many seeds fall to the ground. A small loss of 40 lbs. per acre equals about 10 times a normal rate of seeding. Enough of this seed will survive to create a weed problem in the following crop. Leaving a stand of volunteer sunflowers to produce a crop is *not* recommended as they can cause severe rust losses to the following crop as well as total loss of the volunteer sunflowers. Therefore volunteer sunflowers should be pulled as early as possible. Only then will crop rotation be an effective disease control practice.

2. *Disease Control.* Crop rotation is the main method of reducing serious disease losses in susceptible varieties of sunflowers. Small grains (wheat, barley, oats, rye, and triticale), maize, sorghum, and millets are the best crops to separate sunflower crops in a rotation because they do not support disease-causing pathogens of sunflower.

One or two years' time between sunflower crops in Barani areas should allow all sunflower stalk, root, and head residues to decompose. This will help control rust and other organisms that require sunflower residues for survival. If a disease becomes serious on a particular field, a longer time must elapse between sunflower or other susceptible crops. Other crops

that are susceptible to the same disease that trouble sunflowers are peas, soybeans, flax, rape, mustard, sugarbeets, potatoes, lucerne, sweet clover, safflower, and many weed species. This is another important reason for keeping sunflower fields as weed free as possible.

Your experience and the availability of disease tolerant sunflower varieties will have to be considered each year when making crop rotation recommendations.

3. *Effect on the following crops.* Most research in other sunflower growing areas of the world show that crops yield as well as after sunflowers as after any of the common, non-leguminous field crops.

Even high yielding sunflowers cause less depletion of plant nutrients, on a per acre basis, than corn.

Following are the recommended rotations for Barani areas of the Punjab:—

(1) Sunflower-Wheat-Groundnut

(2) Sunflower-Wheat-Maize

(3) Sunflower-Wheat-Sorghum or Millets.

Wheat can be replaced with any other small grain crop. Other changes may also be made depending on local conditions. In some areas it may even be feasible to grow a spring and a Kharif crop of sunflowers in the same field. For example:

(1) Sunflower-Sunflower-Wheat or other small grain

(2) Sunflower-Sunflower-Groundnuts

(3) Sunflower-Sunflower-Fallow-Maize (or Sorghum or Millets)

Additional research is required before firm recommendations can be made for specific areas.

Cultivation and Weed Control

Weed control is very important in Barani areas and on low fertility soils. Heavy weed infestations may reduce yields by more than 50%.

Weeds will frequently emerge before the sunflowers in Barani areas. These should be killed by harrowing about 1 week after planting but before the sunflowers germinate.

After the sunflower seedlings have two or more leaves a bar harrow, cultivator, or 'Tharpali' may be used. At this stage the sunflower seedlings are usually better rooted than many annual weeds so the harrowing direction may be across, diagonal, or with the rows. It may even pay to harrow the field several times in different directions if weed emergence warrants it.

Hilling at the last cultivation covers small weeds in the row and reduces sunflower lodging that occurs on some wet-soils when high winds partially uproot heavy-headed sunflowers.

Fertilizers

Sunflowers yield best on fertile soils so anything that increases soil fertility is beneficial. It takes about 100 lbs. of nitrogen, 25 lbs. of phosphate ($P_2 O_5$), and 75 lbs. of potash ($K_2 O$) to produce 2000 lbs. of sunflower seed per acre. Soils that can't provide at least this much will yield less.

Research evidence in the specific fertilizer requirements of sunflowers is contradictory. Until more data is analyzed fertilizer application rates may be the same as for maize or sorghum in your area. At least 40-40-0 per acre should be applied and in 30 inch or higher rainfall areas it may be advantageous to apply 40-40-40 per acre.

Many agronomists feel it is worthwhile to band the fertilizers, at least the phosphate and potash, for most efficient use. Nitrogen fertilizer often performs just as well when broadcast as when banded. If the nitrogen source is urea it is essential to work it into the soil during or immediately after broadcasting for most efficient use. Otherwise a significant amount of nitrogen may be lost in the form of ammonia. This is particularly true during warm weather and dry soil conditions.

A practical method of banding phosphate (and potash) is to drop it through a prore" running 2-3 inches along side the seeded row.

Diseases

Normally, diseases are not limiting factors to successful sunflower production during the first few years of cultivation.

To minimize losses from diseases the following practices should be followed:—

(1) Plant only high quality disease free seed.

(2) Avoid planting sunflowers in rotation with crops that are susceptible to charcoal rot, verticillium wilt, and while mold, such as peas, soybeans, rape, mustard, safflower, flex, sugarbeets, potatoes, lucerne, and sweet clover.

(3) Avoid planting sunflowers on poorly drained soils that are subject to waterlogging.

(4) Use a crop rotation such that sunflowers are grown on the same field only once every 2-4 years.

(5) Remove crop residues as soon after harvest as possible.

(6) Destroy volunteer plants soon after they emerge.

(7) Plant disease resistant varieties if available.

The most serious diseases are caused by fungi and include verticillium wilt, downy mildew, rust, and selerotinia stem and head rots. Their symptoms are described below:--

Disease	*Symptoms*
Verticillium Wilt	Symptoms oftern appear before heading. Dead areas along the leaf veins bordered by light green margins. Severely infected plants may die before flowering. Occasionally leaf symptoms don't appear but cross section of stem may reveal decayed vascular bundles.
Down Mildew	Dwarfed plants sometimes only 1 ft. high. Leaves often show contrasting discoloration of yellow green and green. Cottony fungus sometimes on underside of leaves in early morning or after rain. Some plants grow to normal height but have erect heads and much sterile seed. Most severe where much rain occurs immediately before or after emergence. Sometimes blackening and swelling at the base of the stem resulting in lodging. These plants suffer from drought more than healthy plants.
Rust	Rust colored pustules on the leaves, later cause black specks on the stems.
Sclerotina Stem and head rots-	Wilts soon after flowering. If no wilting, a light tan band around the stem at soil level. Black seed from infected heads lack the shine of healthy seed. Meats are discolored. Soft rot starting with brown areas of back of head.

Insects

Open pollinated varieties will not produce high yields unless bees or other insects are present to transfer pollen. One bee-hive per acre of sunflowers placed at the edge of the field during pollination time will ensure enough pollen-carrying insects.

Harmful insect infestations can't be predicted for wide areas but the following preventive practices will help reduce insect damage.

(1) Plantings should be made promptly at the beginning of the Kharif to minimize insect damage.

(2) Practice field sanitation by removing plant residue right after harvest and destroy all volunter seedlings as soon as noticed.

Many common leaf and stem feeding insects that attack other crops also attack sunflowers. These include grasshoppers, cutworms, wire-worms, and woolybea · caterpillars. Aphids are often numerous on leaves after flowering but usually don't require control measures.

Headfeeding insects include grasshoppers, blister beetles, lygus and alfafa plant bugs, and the sunflower head moth (Homoeoroma electellum).

During recent years the major insect causing economic damage has been the 'Toka' grasshopper. Treating the field with 10% BHC dust when 10% of the plants showed feeding damage has provided adequate control.

Additional research on insect control is required before good recommendations can be made for all insect pests of sunflowers. You can greatly contribute to the knowledge of sunflower insect pests by reporting your observations of the specific insect, type of damage, time of year and stage of plant development when attacked.

Bird Damage

Blackbirds, doves, sparrows, parrots and other birds eat tremendous amounts of seed on some fields, usually the smaller ones. If the seeds are filled, the backs of the heads are yellow, and the outer petals brown, prompt harvest is a possible remedy. Bird damage may also be minimized by avoiding planting sunflowers near nesting, roosting, or watering sites. Damage is more severe along the edges of fields, so planting large acreages in concentrated blocks also reduces the percent damaged. Covering individual heads with paper bags is another possible protection measure.

Scarecrows, dummy owls, aluminium stripes that glisten in the sun and rustle in the wind will help. Remember that any sacring device should be in place before the first sign of bird damage is seen. Once birds become used to feeding in a field they are almost impossible to scare away with scaring devices. Birds may start feeding as early as 1 week after bloom.

Harvest and Storage

Sunflowers are mature when the backs of the heads are yellow and the outer tracts brown. The fleshy heads and the stems will still be high in moisture.

If bird damage is not serious, seed curing may take place on the standing stalk. If harvest is required before the seed is completely dry, the heads must be cut and placed in thin layers on an open drying floor with occasional turning. This drying operation will take 5-8 days.

The dried heads may then be threshed by beating with sticks or rubbing them on a rough or slotted threshing board or by a threshing machine.

The seed should then be winnowed to remove all chaff and foreign matter. This helps avoid molding and contamination by insects. Then the seed should be dried below 12% moisture for temporary storage and below 9% moisture for long time storage (2-3 months).

Empty storage containers should be absolutely clean and treated with malathion or other suitable insecticide before being filled.

Harvest and Storage

It is best to also fumigate the seed to kill all insects brought in from the field before placing in sacks or storage containers.

Careful inspections of the stored grain should be made every month for evidence of new insect infestations and additional fumigation given as needed.

Malathion is one of the most useful insecticides for treatment of any grain or seed to be protected from insects during storage. Emulsion sprays prepa ed from premium grade, 57% malthion emulsifiable concentrate, diluted by adding 100 cc to 4 litres of water, and applied as a mist spray uniformally to the grain or seed gives good protection for 2-3 months. This is enough to treat 15 metric tons of grain. Retreatment will usually be necessary in 2-3 months since malathion degrades and becomes harmless in a relatively short period. It also leaves no residue on the treated grain so the grain is not damaged in its value as food for humans or animals if the above directions are followed.

Caution: Keep all pesticides in closed, well-labelled containers in a dry place where they will not contaminate food or feed and where uninformed adults and children cannot make improper use of them. Promptly bury empty pesticide containers. Do not use them for any other purpose.

Sunflower Uses

1. *For Human Food.* The kernels are eaten by cracking the hulls either before or after roasting or cooking. The cake or meal from dehulled seed is an excellent protein food for man, and for non-ruminent animals.

The nutritional value of the sunflower seed protein is exceptionally high for a protein of plant origin but is somewhat deficient in the essential amino acid lysine. The average whole seed protein contents = 12.6%. The nutritional value of the protein in relation to egg protein is 93%, which is higher than groundnuts (69%), soybeans (62%), cottonseed (76%), seasame (63%), or safflower (71%).

For teasted flavour the whole seed is heated at 300 °F (149° C) for 15 minutes in an oven or heated and stirred in a frying pan. If a salt flavour is desired, soak overnite (8-10 hours) in a salt brine (2 tablespoons salt to 1 cup water) boil for a few minutes and then dry with heat. The overnite soaking amy be omitted if the seed is boiled in the brine for at least 20 minutes.

The salted whole seed may also be fried in edible oil for a different flavour.

2. *For Oil.* About 90% of the sunflower seed produced is crushed for oil extraction. Its nutritive value is equal to that of olive oil. Because of

its colour, keeping ability, and the absence of off flovours, it is most suited for margarine production, and as a cooking oil. About 40 lbs. of oil are obtained from 100 lbs. of mature, dry (10% moisture) oilseed sunflower varieties.

3. *For Livestock.* Sunflower seed cake produced by extraction of oil from the unhulled seed is an excellent high protein (about 30)% feed for ruminant livestock. Sunflower seeds are a valuable food for poultry, particularly during the cold months, because of their high protein content. Sunflower hulls make good poultry litter. In Russia the threshed heads are ground and fed to cattle. Sunflower leaves have a high nutritive feed value for livestock but the stalks are relatively poor.

4. *Other.* Industrial uses of sunflower oil are in the production of soaps, high-quality paints, and cosmetics, The stalks can be processed for the production of pulp for the paper industry, and of cellulose. They are relatively rich in nitrogen, calcium, and potassium so shredding the stalks and incorporating them in the soil increases, soil fertility and organic matter content.

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