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Suitable Varieties for Organic Cotton Production

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Paper presented by M. Rafiq Chaudhry, Head, Technical Information Section, ICAC, at the International Conference on Organic Cotton, Cairo, Egypt, September 23-25, 1993. The Conference was held under the auspices of the International Federation of Organic Agriculture Movement, Germany, and the Bio Foundation and IMO Institute of Marketecology, Switzerland.

Abstract

Use of chemicals in the form of fertilizers, herbicides, insecticides, growth regulators, defoliants and desiccants has increased the cost of production to the extent that cotton is losing its profitability against other field crops. Environmental concerns are also increasing. Organic cotton production provides an alternative to grow cotton without chemicals. Organic cotton production requires careful planning so as to realize optimum yield. It includes a number of factors like site selection, crop rotations, variety, weed control, non-chemical means of insect control and skill to manage organic crop. Selection of suitable varieties for organic cotton production will decrease pest attack and harvest optimum yield. Present commercial varieties have been developed for conventional production practices comprised of high doses of fertilizers and stringent plant protection measures. Production practices of early maturing and short stature varieties, commonly grown in many countries, are different from organic conditions. Varieties with less fertilizer needs and better tolerance to insects can prove to be more successful for organic production. Such varieties should be bred under organic conditions. Why present varieties are not suitable for organic production and what type of varieties could be suitable for organic production is given in this paper.

Introduction

The yield of any crop can only be improved if yield constraints or limiting factors are identified and removed. Sometimes the constraints may not be known but are inadvertently resolved. So far in the agriculture sector as a whole, two major constraints or limiting factors were identified and researchers found solutions to them. Continuous use of soil for the production of crops, in the absence of supply from outside, makes the soil unable to meet plant requirements. Scientists found a solution to such a situation and invented synthetic fertilizers to replenish soils deficient in certain plant needs. Synthetic fertilizers were introduced and yields of all crops increased significantly because crop plants did not face limitations of nutrients from soil.

The build-in genetic potential of a plant faced another major setback from insect pests. Scientists once again came to the rescue and devised chemical measures to kill insects, weeds and diseases. Another major jump in yield was observed when such chemical measures were adopted on a commercial scale. No agronomic, chemical or biological insect control measure can improve yield beyond the genetic ability of the plant. All pest control measures are used as aids to protect either the plant or its fruit which contributes to productivity. Cotton, being more vulnerable to insects than almost all other field crops, vegetables and fruit plants, received aggressive use of insecticides worldwide.

Use of Chemicals

Use of fertilizers and insecticides has increased to the extent that cotton production is losing its profitability against other field crops. Environmental concerns are also increasing in society. Researchers have done quite significant work to get rid of highly hazardous chemical compounds used in farming but much more is yet to be done. In the highest yielding cotton countries of the world like Australia, Guatemala and Israel, reduction in the cost of production of cotton is one of the main objectives of researchers.

Except for Brazil, Egypt, Israel and USA (irrigated Southwest), the cost of chemicals is more than 25% of the total cost of production without land rent. The cost of chemicals in Brazil is lower than 25% because of the high cost of picking labor. In Israel, irrigation water is very expensive and costs roughly US$770/ha. In the USA (irrigated Southwest), the cost of fixed items is very high. Organic cotton provides an alternative to grow cotton without the use of chemicals or threat to the environment.

Cost of herbicides, fertilizers, insecticides and defoliants to grow one hectare of cotton under irrigated and rainfed conditions in selected countries is presented in the table on the next page. Total cost per hectare includes all field operations, ginning, economic costs and fixed costs but not land rent.

Organic cotton production is not farming by neglect nor is it

Cost of Chemicals/Ha in Irrigated Cotton in 1990/91 (US$)

Country	Herbicides	Fertilizers	Insecticides	All Chemicals (% of total cost)	Total Cost
Australia	42.6	78.9	377.1	32	1,578.7
Egypt	11.4	94.1	15.2	19	646.0
India		116.4	190.3	35	875.1
Israel	72.5	301.3	355.0	18	4,117.4
Pakistan		43.3	72.9	32	367.7
Peru		202.0	207.8	27	1,535.1
Turkey	9.24	70.9	432.4	28	1,855.5
USA*		142.2	198.7	17	2,020.5

Cost of Chemicals/Ha in Rainfed Cotton in 1990/91 (US$)

Australia	22.1	41.8	130.2	25	766.9
Brazil	12.2	49.2	49.8	15	721.9
Guatemala	13.4	59.2	470.0	32	1,672.8
India		45.6	80.6	30	421.8
USA*		85.8	194.6	25	1,121.7
Zimbabwe		57.7	42.0	32	315.8

* In the case of the USA, herbicides are included under insecticides.

leaving the crop at the mercy of the insect pests and diseases. Soil fertility has to be maintained through organic fertilizers and insect pressure has to be kept at the minimum otherwise yield will be very low. Whether the presently available commercial varieties are suitable for organic production or whether new varieties have to be developed that can adapt to this changed set of environment is an important consideration for organic production.

Cotton Breeding

Breeding for superior varieties has received the full attention of researchers in most countries. Breeders have done a wonderful job in modifying the plant to meet the needs of growers. But at the same time, it would be true to say that the breeders have appropriated the credit deserved by a team from various disciplines. In the past two decades, emphasis has been on varieties shorter in stature, early in maturity and responsive to high doses of fertilizers. Shifting effective fruiting positions closer to the main stem and to lower positions has been tried. High response to fertilizers and a shift in fruiting positions are desirable characters for high input use but may not be when no fertilizer has to be applied. Similarly, the response of early and closer to the main stem fruiting needs to be investigated in comparison with genotypes with scattered fruiting positions on the plant.

Commercially grown varieties have been tested under high input conditions as they had to be developed for such conditions. Under such conditions any genotype not performing well will automatically be discarded. Varieties performing well under optimum conditions may not be able to maintain their yield level without synthetic fertilizers and insecticides. The breeding material for organic cotton production has to be screened under organic conditions. F_2 single plants, progeny rows or bulks should be continuously grown under organic conditions to select a variety for organic production.

Fertilizer Needs

Short stature plants are expected to behave differently in the absence of synthetic inorganic fertilizers. Early maturing varieties, which are usually shorter in stature, enter into fruiting phase earlier than tall growing cultivars and are also meant to form bolls at higher rate. Such genotypes need fertilizers from the soil for the optimum realization of yield potential and any setback at this stage is directly related to loss in yield. Admitted that in the case of organic cotton production fertility of the soil will be maintained through green manuring and organic fertilization, but the availability of nitrogen to the level of inorganic fertilization cannot be obtained. In the absence of sufficient supply of nutrients from the soil, the plant will fail to express its optimum potential, increasing the gap between genetic ability of the plant and its phenotypic performance in the field. Short plants are expected to remain substandard, thus producing less fruiting and ultimately less yield.

Genotypes that perform well under high input conditions will not necessarily perform well when grown under organic conditions. Hardy genotypes can be developed which do not have a very high yield level as obtained under conventional production but can give the best yield when soil will not be supplemented with synthetic fertilizers. I suspect that these genotypes will be short in stature. I also assume that genotypes that can perform better under organic conditions will result in rank growth if synthetic fertilizers are applied.

Insect Control

The cotton plant is naturally vulnerable to a variety of insect pests. Under organic cotton growing conditions, the crop is going to be attacked by the same insects. The insect attraction may be less because of less lush crops. The cotton plant has one of the best built-in compensation systems compared with many field crops. It can make up the loss occurred at early stages but cannot make up the loss caused after a certain period, the reason being that all cotton growing conditions have a certain cut-out period when the plant ceases to bear more buds and flowers. This may happen because the plant becomes physiologically exhausted and is unable to carry out physiological processes at the required rate or the ambient conditions have changed which do not permit normal growth. Hence, all-out efforts have to be made to save the maximum number of flowers from the very beginning.

There is no doubt that cultural, biological and other non-chemical means of insect control are environmentally friendly and very desirable, yet the fact remains that they cannot eliminate insecticides. Certainly, they have the potential to reduce the use of toxic chemicals. Under the circumstances, there is going to be higher insect pressure on the plant in the absence of insecticides. The plant's own system to repel insects or resist insects

can contribute greatly to avoid heavy losses. The significance of certain special morphological characters will increase as in the case of prevalence of jassid, *Empoasca devastens*. If jassid is a major insect where organic cotton will be produced, profusely hairy varieties will be more desirable. Multi-Adversity Resistance can play a greater role in organic cotton production than growing cotton under normal conditions.

Fiber Quality

Fertilizer application has a significant impact on fiber quality. Fiber length, fineness and maturity are more affected than other quality parameters. The absence of high doses of nitrogen at the time of boll formation and maturation is going to give comparatively shorter fiber length and higher micronaire value. Maturity is also expected to improve. How much this change is going to be desirable depends on the response of a variety to the changed situation. Seed maturity and ginning outturn are also expected to improve. Defoliants and desiccants, which make the crop mature in the minimum possible time, including forced opening of late formed bolls, will not be used in organic cotton production. Elimination of defoliants and desiccants is going to have a favorable impact on quality in the form of better uniformity, particularly for micronaire, maturity, staple length and fiber strength.

Yield Loss

Cotton production practices have changed from when there were no synthetic fertilizers and chemical means of insect, weed and disease control. It is difficult to say whether organic cotton production is a step forward or reverting back to the previous situation of no synthetic fertilizers and insecticides. In cotton production, we have the knowledge and highly effective means to save the crop from yield losses, but we are not supposed to make use of them in organic production. Some loss in yield is certainly expected. The magnitude of loss will depend upon a number of factors, i.e., variety, soil fertility, pest pressure, skill in handling organic cotton production, etc. I will categorize variety and grower's skill as the most important as they can play a great role in minimizing the loss in yield compared with conventional production.

Loss in yield will also depend on the situation where cotton is grown. If it is an area of high pest pressure and a variety of insects appear simultaneously, chances are that insects might take a heavy toll. Comparatively tolerant varieties, even at the cost of slightly less yield potential, will be more suitable under such conditions. The magnitude of loss acceptable to the grower mainly depends on the price he gets for his organic cotton.

Conclusions

- Presently grown commercial varieties of cotton have been developed to give optimum yield under high doses of fertilizers and stringent plant protection measures.
- New varieties need to be developed for organic cotton production. The breeding objectives would be better tolerance to insect pests and diseases and maintaining a high yield level without any synthetic fertilizers.
- A lack of nitrogen supply from the soil and insecticide coverage will affect yield significantly.