Issues Related to Sunflower Breeding and Seed Production in India

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Abstract :

In recent years, India has emerged as a leading sunflower producing country in the Asian Continent. There has been a shift in breeding emphasis from population breeding to heterosis breeding. Presently, more than a dozen single cross hybrids based on *Petiolaris* source of cytoplasm are cultivated over wide range of agroclimatic conditions. In heterosis breeding, to develop heterotic hybrid combinations, parental lines themselves should have high self-fertility, seed yield and oil content coupled with resistance/tolerance to major diseases (alternaria, rust and downy mildew). Identification of hybrids for stress environment should be given importance in coming years. The parental lines should possess high test weight to reduce yield loss in processing. There should not be more than 3 to 5 days difference in flowering duration of parental lines in the best heterotic combination identified for commercial cultivation. Maintenance of genetic purity of parental lines through paired crossing and "Method of Reserve" helps in imparting stability for both seed yield and oil content over locations and years. Manipulation of fatty acid composition, diversification of cytoplasmic base and development of high yielding hybrid cultivars of different maturity groups (early, mid and late) suitable for varied agroclimatic conditions has been discussed.

In India, Oilseeds are grown in 26.8 mha yielding 21.5 mt. Groundnut and rapeseed mustard the two major oilseed crops of the country account for 55 per cent of the total acreage and 61 per cent of total oilseeds production. During 1993-94, sunflower, with an area of 2.7 m ha and production of 1.4 mt accounted for 6.5 per cent of total production. In India, commercial cultivation of sunflower started with open pollinated varieties. During 1979-80 it was grown over an area of 0.61 lakh ha mainly in three Southern states. The spectacular rise in acreage is attributed to large scale cultivation of high yielding hybrid cultivars. Besides, its cultivation has recently spread to non-traditional areas of northern parts of India.

Status of Sunflower Cultivation in Seventies : Improved sunflower populations introduced from erstwhile USSR and Canada were evaluated across the country. The results of varietal evaluation revealed superiority of EC 68415 (Armaviriskii-3497) for Karnataka State and EC-68414 (Peredovik) for other sunflower growing states. Commercial cultivation of these two open pollinated varieties started in early seventies with meagre 20,000 ha. However, it did not catch the attention of farming community as a profitable crop because of poor seed filling, low yield levels, low oil content, low market price, damage due to birds and susceptibility to diseases and pests. Realising the potentiality of the crop under dry land farming and to sustain its cultivation, genetic improvement of sunflower was started in 1972 with the establishment of five research centres. The importance of maintaining yield stability and *per se* oil content of open pollinated varieties was soon recognised and five seed production centres exclusively for production of quality seeds were established in 1977. The research in the formative years was quite broad based and embraced many facets in multi-disciplinary approach. The research thrust on varietal improvement resulted in the development and release of new populations viz., Surya, Co-1, Co-2, SS-56 and Morden (Cernianka-66). The importance of heterosis breeding was recognised early and testing of experimental hybrids started as early as 1975. The scientific seed production technology gave boost to large-scale cultivation of sunflower in late seventies as availability of quality seed imparted production stability for both seed oil yield of improved open pollinated varieties (Giriraj *et al.*, 1985).

Status of Sunflower in eighties :

Heterosis breeding initiated in mid-seventies, resulted in the development and release of first ever sunflower hybrid - "BSH-1" from Bangalore Centre (Seetharam, 1981). It recorded 25 to 30 per cent increase in seed yield over cultivated open pollinated varieties. Release of BSH-1 in 1980 gave impetus to heterosis breeding. Subsequently array of high yielding hybrid cultivars in both public and private sector were developed and released. These include APSH-11, KBSH-1, LDMRSH-1, LDMRSH-3, MSFH-1, MSFH-8,

MSFH-17, Sunbred-212, ICI-308, Advance, etc. These hybrid cultivars are presently cultivated in major sunflower growing states. The mean seed yield potential of hybrid cultivars under assured rainfall tracts and under irrigated conditions vary from 20 to 25 q/ha. Sunflower cultivation dominated earlier by open pollinated varieties was gradually replaced by high yielding hybrid cultivars.

Perspectives in ninetees :

Sunflower cultivation in India has witnessed many ups and downs in the last two decades. With a negligible area and production in 1979-80, it has exhibited a great leap forward with about 3 mha acreage and 2 mt production during 1994-95. The limiting factors associated with the crop during seventies are no more problems of ninetees. Nevertheless, the problem of low productivity (6 quintals/ha) still persists which could be successfully overcome through proper blending of research and development efforts. In the following paragraphs, some of the important approaches for increasing productivity have been pointed out.

1. Development of self-fertile hybrids :

Hybrid cultivars, in general, are more self-fertile compared to open pollinated varieties. The problem of poor seed filling is confined to tropical countries like India. Honey bees are the most efficient pollinators and thus help in alleviating the problem of poor seed filling. However, in major sunflower cultivated areas, bee activity is minimal and as a result expected yield levels are not realised. In this context, development of high self-fertile hybrids assumes importance. The germplasm material should be evaluated for self fertility and used in heterosis breeding. The parental lines involved in a hybrid combination should exhibit high level of self-fertility as it ultimately influences seed set in the synthesised hybrid as well (Swamygowda and Giriraj, 1989).

2. Diversity in cultivars :

In India, sunflower is cultivated under different agroclimatic situations. It is grown in three distinct

seasons - *viz.*, rainy, post-rainy and summer/spring seasons. Presently cultivars are same for all the three reasons. There is need to identify high yielding cultivars suited to different farming situations. In particular, for post-rainy season, which is characterised by its stored residual moisture conditions, high yielding and early maturing (80 to 85 days duration) cultivars are desirable. Development of early hybrids with seed potential of 15 to 20 q/ha would also find place in multiple cropping system. Attempts should be accelerated to develop location specific hybrids with different maturity groups (early, mid and late duration) suited to different farming systems and stress situation. There is scope to further increase area under hybrid cultivars.

At present, without exception all CMS lines used in heterosis breeding programmes have cytoplasmic source derived from *Helianthus* petiolaris (CMS-F). It is a known fact that use of single cytoplasmic source limit the genetic base besides involving risk factors for new strains of disease. In USA, Canada and European countries new cytoplasmic sources (CMS-PF, CMS-I, CMS-K, CMS-BOL, CMS-397, CMS-519, CMS-521, CMG-1, CMG-2 and CMG-3) derived from wild species are being attempted in lieu of *Petiolaris* source in heterosis breeding (Anaschenko, 1974; Leclereq, 1980; Heiser, 1982; Whelan, 1980; Serieys and Vincourt, 1987). Work on development of new alloplasmic lines with desirable agronomic traits should also be initiated.

Fatty acid composition in sunflower is influenced by environmental factors. Crop raised in rainy season accumulates more of linoleic acid (18:2) while summer raised crop accumulates more of oleic acid (18:1). Stable, true breeding high oleic containing progenies are now available (Soldatov, 1976; Urie, 1985; Fernadez-Martinez *et al*, 1988). Therefore, emphasis may be laid in coming years on development of hybrid cultivars with high oleic acid.

3. <u>Breeding for disease resistance</u> :

With increase in acreage, there has been gradual increase in inoculum build up and disease intensity. Until 1983, diseases were restricted to Alternaria leaf spot

(*Alternaria helianthi*) rust (*Puccinia helianthi*) and several forms of root rot, stem rot, head rot (*Sclerotinia sclerotiorum*). During 1984, occurrence of downy mildew (*Plasmopara halstedii*) was reported in Maharashtra state (Mayee and Patil, 1986). In coming years, hybrids resistant to downy mildew should form part of breeding strategy to contain further spread of this deadly disease. Identified resistant sources for rust be utilised for incorporating rust resistant genes in hybrids.

4. Strengthening of production technology for hybrid seed :

With increase in acreage under hybrid cultivars, there is urgent need to strengthen the existing infrastructure facilities and develop suitable seed production technology for maximising hybrid seed yield. At present ratio-system of seed production (3 female: 1 row of restorer line) which is based on sound scientific footing is in vogue. This method ensures natural pollination. However, this method is not suited when parental lines of a hybrid differ in flowering. Under such situation, block planting of suitable size is adopted which helps for staggered planting. Experience has shown that there should not be more than 3 to 5 days difference in flowering behaviour of parental lines involved in the best heterotic combination identified. In hybrid seed production plots manual hand pollination (4 to 5 times) is followed. Honey bees (*Apis dorsata, A. cerena indica and A. florea*) are the most efficient pollinators in addition to other 20 different pollinating agents. Although bee activity is desirable in commercial sunflower fields or seed plots of varietal populations to promote seed filling, in hybrid seed production plots, bee activity, is not desirable as it is restricted to male (restorer) plants and occasionally visit female line (Cytoplasmic male sterile). It results in devoid of pollen for manual cross pollination in seed plots. Inadequate availability of dehiseed pollen for effective pollination owing to "pollen theft" by natural pollinators has come in the way of producing reasonable quantity of hybridseed. Besides, seed processing loss of 20 to 30 per cent is presently encountered. Optimisation of sieve size in processing helps in minimising seed yield loss. To reduce loss in seed processing, it is suggested to use parental lines with high test weight. In India, on an average hybrid seed yield of 5 to 6 q/ha is realised and as a consequence the cost of hybrid seed is quite high.

Over years, there will be decline in yield of hybrid cultivars, which may be due to deterioration in the

characteristics of parental lines. Maintenance of genetic purity of parental lines through paired crossing at regular intervals and adopting "Method of Reserve" based on Pustovoit model helps in imparting stability for both seed yield and oil content. In brief, there is need to develop package of production technologies for maximising hybrid seed yield in seed production plots.

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