GARLIC BREEDING - A REVIEW

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ABSTRACT

Garlic is second most important bulb crop after onion. It is an important spice crop belonging to family Amaryllidaceae. Despite the importance of crop, very limited breeding work has been done so far. As a first step of systemic breeding programme, collection and evaluation of germplasm is required. Clonal selection of local existing types in various regions is the important method of improvement. Estimation of correlation and path analysis are useful in developing suitable selection criteria for selecting desired plant type or developing high yielding varieties. Improvement techniques like polyploidy, mutation breeding and tissue culture have helped in improving the garlic traits.

The garlic bulb is a compound bulb consisting of small bulblets or segments called cloves. Since garlic is propagated exclusively by vegetative methods clonal selection of local existing types in various regions is the important method of improvement. In the hill districts of U.P., cv. 'chauballci' was found to be a very promising clonal selection in respect of bulb size and yield. In different regions of India good number of local strains are available. They vary in number of cloves, ranging from 16-50/bulb and the size of bulb.

Despite the importance of crop, very limited breeding work has been done so far. As a first step of systemic breeding programme, collection and evaluation of germplasm is required. The adequacy of germplasm collection is determined by the amount of genetic variability present in the germplasm. Assessment of variability present in these genotypes is helpful in selection of suitable genotype. Correlation estimates between bulb yield and its components are useful in developing suitable selection criteria for selecting desired plant type or developing high yielding varieties. Path analysis is helpful in choosing the character(s) that have direct effect on yield. Improvement techniques like polyploidy, mutation breeding and tissue culture have proved beneficial in increasing yield of garlic. These techniques have helped in improving major genetic and physiological traits. They have been also used for incorporating resistance to fatal diseases.

The recent literature pertaining to the breeding of garlic is briefly reviewed.

GENETIC VARIABILITY

Studies on genetic variability in garlic indicated high phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) for average weight of cloves, plant height, bulb weight, number of cloves/bulb (Shaha et al., 1990; Agrawal, 1999). The variation for different morphological characters, yield and yield components among different genotype of garlic have been reported by Vijay (1990) and Kohli and Fageria (1992).

High heritability along with high genetic advance was observed for plant height, average weight of clove, number of cloves per bulb and bulb weight (Korla et al., 1981; Shaha et al., 1990; Agrawal, 1999). High phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was observed for weight of 50 cloves, plant height and bulb weight (Shaha et al., 1990; Agrawal, 1999).

CORRELATION COEFFICIENT

The significant positive correlation of bulb yield with leaf length and height was observed by Lokhande and Pawar (1988) and Srivastava et al. (1993). Plant height, bulb weight, average weight of clove and bulb diameter, showed significant positive
correlation with bulb yield (Kalloo et al., 1982; Shaha et al., 1990; Baiday and Tiwari, 1995; Agrawal, 1999).

Number of cloves per bulb showed significant positive correlation with yield (Shaha et al., 1990; Kohli and Mahajan, 1993; Agrawal, 1999). Kohli and Mahajan (1993) reported that dry leaf weight was positively and significantly correlated with yield. Plant height, number of leaves per plant showed positive association between them.

Korla and Rastogi (1979 a) reported that weight of 20 cloves and bulb weight were associated positively with bulb yield whereas cloves per bulb had negative correlation with weight of 20 cloves in garlic. Moravec et al. (1974) observed positive correlation between bulb yield and clove weight and between number of cloves per bulb and bulb weight of garlic. The significant positive correlation between bulb yield and bulb size of garlic was reported by Trippel and Chubrikova (1976).

**PATH COEFFICIENT ANALYSES**

Singh (1981) reported that clove weight and leaf length had the maximum positive direct effect on bulb weight. Further, he suggested that genotypic selection for improving bulb yield in garlic should be based on clove weight and leaf length.

In a study comprising 22 genotypes of garlic conducted for two years, Kalloo et al. (1982) observed direct contribution of bulb weight, clove number and plant height during 1978 and those of plant height, bulb diameter, weight and number of cloves per bulb during 1979 towards yield. Indirect effect has indicated that diameter of bulb, plant height, length of clove and weight of clove contributed maximum via weight of bulb during 1978.

Srivastava et al. (1993) reported that plant height had maximum positive direct effects on bulb weight however, its indirect effect via leaf width and number of leaves. Agrawal (1999) reported that bulb weight had the highest positive direct effect on the bulb yield followed by bulb diameter, plant height and weight of 10 cloves.

**IN-VITRO TECHNIQUES**

In *in-vitro* technique the plant organism tissues or cells are cultivated in the test tubes or in artificial media.

Lu et al. (1982) differentiated green shoots from callus induced from young leaves of zips in 11% of cases on MS (Murashiva and Skoog) medium supplemented with 0.5 mg/ NAA and 3 mg/IBA. Rooting was achieved in 84% of cases on MS medium alone.

Marchesi (1985) reported those methods of garlic breeding based on *in-vitro* technique. These include the use of some clones, mutation and material of different polyploid levels. Conci et al. (1986) tested through various treatments for disinfecting apical meristem, soaking for 15 minutes in 5% NaOCl gave the best results. Explant growth and development was best in all cloves (Chomam, Puso, Peruana, Colorado, Valenciano and blanco) and a basal murashige skoog medium supplemented with 0.1 mg/litre IAA + 0.1 mg/liter kinetin. Lee et al. (1988) reported that callus proliferation and shoot production from callus culture were greatest in the presence of IAA at 2 mg/liter; IBA and BA had little effect.

Nogasawa and Finer (1988) composed five auxins for their ability to induce morphologically regenerable callus in explants from *Allium sativum* cv. Howaito-Roppen. The most affective auxin was 2, 4-D (0.1-3.0 mg/litre). Gorecki and Gorecka (1989) reported that tissue culture techniques could be applied in propagating these crops for breeding and commercial purpose presented under the heading (i) methods of micropropogation; anther culture; ovule culture; cybridization; micropropogation and (ii) significance of
techniques and conditions of carrying out in vivo cultures.

Maggioni et al. (1989) studied that optimum callus induction from leaf explants of N. Bianco Piacentino was achieved on MS medium supplemented with 2 mg IAA, 0.5 mg 2,4-D and 0.1 mg Kinetin per litre. Shoots were regenerated on MS medium containing 2 mg IAA and 4.5 mg kinetin per liter and rooting was induced on MS medium with 10 g sucrose and 0.1 mg IBA per liter. Matsubara and Chen (1989) obtained good bulb formation after 60 days transferring plantlets to a medium containing NAA and BA at 0.1 mg/litre. Matsubara and Chen (1989) obtained good bulb formation after 60 days transferring plantlets to a medium containing NAA and BA at 0.1 mg/litre. Matsubara and Chen (1989) obtained good bulb formation after 60 days transferring plantlets to a medium containing NAA and BA at 0.1 mg/litre.

Highest rate of plant regeneration was obtained with using callus from leaf primordia of explants transferred to MS medium containing 1.0 mg IAA and 2.0 mg kinetin per litre and no 2,4-D. (Mariconi et al., 1989; Conci et al., 1987).

POLYPLOIDY

The garlic crop have been the subject of considerable polyploidy study. In certain cases polyploids have been evolved spontaneously in nature whereas in most of the cases these have been artificially induced. Generally haploids, diploids and tetraploids were experimentally induced and studied.

Maggioni and Marchesi (1984) studied on variety Bianco Piacentino produced in vitro from explants of fresh shoots or of leaf tissue in the bulb. The latter produced the more callus. Analysis of some of the callus tissue showed that it contained 45.9% diploid cells, 4.1% haploid, 2.7% triploid, 14.9 tetraploid and 12.3% aneuploid, the remaining 20% had very high chromosome.

MUTATION

Choudhary and Dnyanansagar (1982) exposed to various doses of X-ray on cloves of garlic and a range of concentrations of ethyl methones sulphonate (EMS), diethyl sulphate (DES) and ethyleneimine (EI). In the second and third vegetative generations 16 types of morphological mutant were recorded at various frequencies. The most effective agent was X-radiation followed by EI, EMS and DES.

Gohil and Koul (1984) found that irradiation of garlic with different doses of X-rays, reduced mitotic activity and induced chromosome aberrations. Dedul et al. (1985) observed that as the X-rays dose increased, the rate of shoot production declined. At low doses (1-3 GY) there was little differences between irradiation plants and control in growth rate and seed production. A-12 GY dose proved lethal for garlic before their observations were recorded in M1 and M2 generation.

PROMISING VARIETY AND YIELD

The varieties developed are Godavari and Sweta at MPKV Rahuri; HG 1 and HG 6 at CCSSHAU, Hisar, Pusa Sel. 10 at IARI, New Delhi, LCC 1 at PAU, Ludhiana, ARU 52 at VPKAS, Almora and Agrifound White (G 41), Yamuna Safed (G 1). Yamuna Safed 2(G50), G 282 and Agrifound Parvati at NHRDF. These varieties are mostly small bulbed and have more number (20-30) of smaller cloves. G 282 and Agrifound Parvati have bigger bulbs with bigger cloves and cloves are fewer in number. The characters of some of these varieties are given in following Table:

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<th>Varieties</th>
<th>Characters</th>
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<tr>
<td>Agrifound White (G 41)</td>
<td>The bulbs are compact, silvery-white skinned with creamy-flesh. Diameter of bulb is 3.5-4.5 cm and number of cloves/bulb is 20-35. The variety is susceptible to purple blotch and stemphylium blight which are common in northern India. TSS 41%, dry-matter 43% and good storer. Average yield is 13 tonnes/ha.</td>
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<tr>
<td>Yamuna Safed (G 1)</td>
<td>The bulbs compact silvery-white skinned with 25-30 sickle shaped cloves and creamy flesh. Diameter of bulb is 4.0-4.5 cm. it is tolerant to insect pests and diseases like</td>
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Yamuna Safed 2 (G 282)

The bulbs are compact, attractive with 35-40 cloves/bulb and white-creamy flesh. Bulb diameter is 3.5-4.0 cm; TSS 38-40%; dry-matter 40-41%. The average yield is 15-20 tons/ha. The variety is recommended for northern parts of India.

Agrifound Parvati (G 313)

A selection from the material collected from Hong Kong market. It is a long-day-type and as such is suitable for cultivation in hill of northern states. Bulbs are of bigger size (5-6 cm diameter), creamy-white with pinkish-tinge, 10-16 cloves/bulb, tolerant to common diseases. Average yield 17.5-22.5 tonnes/ha. It is medium storer and suitable for export.

Korla and Rastogi (1979 b) studied eleven garlic genotypes and reported that GC-9 had the highest yield whereas, highest bulb size and number of cloves per bulb were produced by genotype GC-11. Pandey and Singh (1989) obtained highest plant height, number of leaves per plant, number of cloves per bulb, weight of bulb and yield in garlic genotype HG-1.

Batra et al. (1994) tested seven varieties of garlic for three years at Hisar. All the varieties yielded more than 100 q/ha. Variety G-1 produced highest yield (153.0 q/ha) and large size bulb (32.32 g) followed by G-50. The maximum number of large size cloves (37.4) and minimum small size cloves (23.8 %) per bulb were recorded in variety G-282. On the basis of the results the variety G-282 was considered to be best. Baiday and Tiwari (1995) evaluated 30 genotype of garlic and observed that genotype G-61 had the highest bulb yield (6.84 t/ha) whereas IC 25599 had the lowest (1.87 t/ha).

Agrawal (1999) evaluated 17 genotypes of garlic at Jobner and observed that the genotype Jajavar-local was the highest yielder followed by G-1 and Chabra-local. These genotypes were also among the top genotype for economic traits such as bulb size, bulb diameter which were the main component traits contributing towards increased bulb yield. Chabra-local had the least intensity of purple blotch (8.40%) and was considered as resistant genotype.

Ayala and Savon (1986) studied that the var. Guadalupe 15, Guadalupe 25, Seneti spiritus 3, Hov-1 gave the highest yield (7.6-0 t/ha) and Martinez, Hov-1 was the lowest susceptible to *Alternaria porri* tulipae. Zimerer et al. (1988) recorded the highest yield from the cultivars seleacojetiba (7793 kg/ha), Gigante Roxao (5333 kg/ha), cultivra (5150 kg/ha) and Seleaco Regional (5060 kg/ha).

Khvatysh et al. (1980) reported that the best varieties for dry matter and sugars content were K280u, K-2846, K-2765, K-2761, K-2818, K-2766 and a local variety from Abkhazia. Ignotev (1983) obtained promising variety by clonal selection, viz., Poretskii, Chuvashskii, and Cheboksarskii. Likhaiskii (1984) observed that vat. Volynskii Mestnyi produced more-cloves per bulb (11-13), followed by odeniskii Mestniy and Yampoliskii (both 10-12). Heaviest bulbs were produced by odeniskii Mestnyi (34-53 g) and Vinnitskii Mestnyi (34-46 g). Taicangbai has large white bulb (30 g). The mature bulb have a relatively long dormancy period and sprout late and yield of dry bulbs were 30-35% higher than those of common garlic (Chen 1986).
soviet variety “Garlic Egorlyksskii” developed through clonal selection having good frost resistance and total yield is 8-10 t/ha.

**BREEDING FOR DISEASE RESISTANCE**

Although there is wide diversity in *Allium sativum* for clove size and bulb size; there is a lack of sources of resistance to *stemphyllum* blight and purple blotch, which vary in severity in many parts of India. NBPCR has evaluated 764 accessions and recorded diversity for a number of morphological attributes. Agrawal (1990) screened 17 genotypes of garlic and reported that genotype Chabra-local had the least intensity of purple blotch (8.40 %) while maximum disease intensity was recorded in genotype G-41. Thus there is further scope for the evaluation of garlic germ-plasm for several diseases like purple blotch *stemphyllum* blight, tipburn etc. which are serious problems in several part of India.

**REFERENCES**


