1. INTRODUCTION

The establishment of the gigas mutants of Oenothera lamarckiana by Lutz (1907) and Gates (1909) as polyploids, and also the discovery of polyploid nature of several of the common cultivated plants, like wheat, potato, tobacco, cotton, sugarcane, etc., aroused much interest on the mechanism of doubling of chromosome sets in nature. Before long, attempts were under way to create polyploids artificially. Notable among the early methods for experimental production of polyploids have been : decapitation and callus methods of Marchals (1909) and Winkler (1916), heat-shock method of Randolph (1932), centrifuging method of Kostoff (1938), hormonal treatment of cut surfaces by Greenleaf (1938), and twin seedling method for isolation of polyploids by Muntzing (1938). However, the epoch-making discovery by Blakeslee and Avery (1937) of the polyploidizing property of the alkaloid colchicine developed through the cytological discovery by Dustin et al. (1937) has supplanted the earlier methods for the artificial induction of polyploidy in plants.

With the advent of colchicine technique polyploids were artificially produced in a large number of plants. But most of the induced polyploids could not be used immediately in preference to their diploid progenitors mainly due to their reduced fertility. Nevertheless, great variations in fertility have been observed, not only from species to species but also in different varieties or strains of the same species, varying from total sterility to values as high as 75 per cent fertility. The differential response between varieties or strains to induction of polyploidy has also been noticed in other morphological and physiological characters besides fertility, as, for instance, increase in size of the vegetative and reproductive parts (Levan, 1942, and Kuckuck and Levan, 1951, in linseed types; Müntzing (1948) in barley; Bohn, 1947, and Nilsson, 1950, in tomato, etc., etc.

Furthermore, it has been shown that by selection among the progenies of tetraploid and also in the progenies of hybrids between tetraploid varieties or strains fertility levels could be raised appreciably. Some of the notable examples where selection has brought about considerable improvement in yield are : *Linum* by Schlosser (1944), and Kuckuck and Levan (1951); barley by Muntzing (1948). In several cross-fertilized crops like red clover (Levan, 1948), rye (Muntzing, 1951), *Brassica* (Parthasarathy and Rajan, 1953) greater success could be achieved with selection owing to the heterozygosity in the material. Nevertheless, in some instances autogamous plants also responded well to selection by the adaption of suitable technique. Thus, Levan (1942), and Kukk (1943) in *Linum*, and Muntzing (1948) in barley obtained higher degree of fertility by utilization of large number of diploid lines for induction of tetraploidy and subsequent hybridization between intervarietal tetraploids.

Some of the undesirable characters of the tetraploids like slower rate of growth and reduced fertility may be compensated by other desirable characters, such as prolonged growth period, gigas plant features, larger seeds, and higher protein, vitamin and such other chemical constituents, etc.

The development of tetraploid steel rye by Muntzing (1951) has brought to light the existence of differences among the several varieties of the same species towards the induction of tetraploidy and also the existence of a favorable balance between positive and negative characteristics. The slight lower seed setting, reduced tillering, lower number of flowers per spike, and tendency to shed basal spikelets are counterbalanced by the larger size of the seed, superior baking quality of the flour, and the improved sprouting ability of the seed. The remarkable achievements in the breeding of tetraploid forage legumes, such as red and alsike clover, in the Scandinavian countries indicate the possibility of obtaining greater success with forage crops where the seed yield is of secondary importance

As a part of the project on the induction and study of tetraploids of seed and forage legumes, this work was taken up with three seed-cum-forage legumes, namely, cluster bean (Cyamopsis tetragonoloba DC.), horse gram (Dolichos biflorus L.), and soybean (Glycine max (L.) Merr.).

With the creation of polyploids in several of the cultivated plants it has become apparent that chromosome doubling in plants originally having low chromosome numbers will be more promising than those with comparatively high numbers.

Kostoff (1940) has cited some examples to show that species with smaller chromosomes exhibit lower degree of sterility than those with larger chromosomes. The three plants were chosen to represent two Indian legumes and an introduced one (soybean) with low, medium, and high chromosomes numbers. The chromosomes in all the three plants are small, but among themselves those of cluster bean are larger and few in number (2n = 14), those of horse gram smaller and intermediate in number (2n = 20)* and those of soybean medium-sized and high in number (2n = 40).

As the plants are self-fertilized, a large number of varieties with a much diverse characteristics as possible were selected to facilitate intervarietal hybridization and thereby improve the fertility. Since all the three plants are to a large extent utilized as forage and green manure crops, production of polyploids with their characteristic intensified vegetative growth would be advantageous even if the fertility is reduced. In soybean, where despite the high nutritive value of the seeds, it is not popular in India owing to its high oil content; there is possibility of increasing the palatability by reduction in oil content and further increasing the protein content at the tetraploid level as found by Porter and Weiss (1948) in both their tetraploids.

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* The chromosome number of all the horse gram varieties used in the present investigation was found to be only 2n = 20, although it was reported earlier as 2n = 24 by Rau (1929).

Cluster bean, or guar, belongs to the genus *Cyamopsis*, (*C. tetragonoloba* DC. syn. *C. psoralioides* (L.) Taub.) of the tribe Galegeae. It is probably indigenous to India, though it has never been found in a wild state. According to Chevalier (1939) the genus *Cyamopsis* comprises of two more species, viz., *C. senegalensis* and *C. stenophylla*, both are annual herbs growing wild in arid and semi-arid regions of Sudan, Sahara and Arabia. The plant is hardy and drought resistant with a wide range of adjustability. It is an annual erect herb, usually growing to a height of 3-10 feet, bearing clusters of thick fleshy pods. There are several varieties under cultivation throughout India, distinguished by the height of the plant, and size and shape of the pods, adapted for cultivation in different seasons.

The young pods are used as a fresh vegetable or preserved after drying and salting for later use. The whole plant and the seeds are used as cattle fodder. The young plants are good green manures. The seeds yield a mannogalactan gum usable in food, paper and textile industries, for which the plants are now being tried in the arid regions of U.S.A. The gum is favored as a stabilizer and thickener in salad dressings, ice cream and baking products.

Horse gram, also known as kulthi bean, is a native of India and is distributed throughout the tropical region of the old world. It is included in the genus *Dolichos* (*D. biflorus* L.) under the tribe Phaseoleae. Several varieties of horse gram differing mainly in the time of maturity, color of the seeds are cultivated in India.

The crop can be grown practically on all types of soils except the highly alkaline ones. It is hardy and drought resistant like cluster bean. It is an autumn crop sown usually during August-September and harvested after about 4-5 months.

The seeds of horse gram are extensively used in South India as a pulse and as feed for horses and cattle. Stems, leaves and split husks are also used as cattle feed. As the crop can be grown on poor soils with moderate rain fall it is often used as a preparatory crop on new lands to enrich the soil.

Soybean(*Glycine max* (L.) Merr.) is a native to Eastern Asia. It is included in the tribe Phaseoleae. The soybean is considered to be one of the oldest cultivated crops and its antiquity can be traced in Chinese literature to as far back as 2838 B.C. In India, soybean has been introduced a few decades ago.

It is chiefly cultivated for the seeds which are very rich in protein(38-42 per cent) and fat (16 - 17per cent). The seeds are easily digestible. The soybean oil is used in shortening, oleomargarine, mayonnaise, salad dressing, etc. The plant is also used as hay, and green manure. A large number of varieties with great diverse characteristics exists.