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RESEARCH ARTICLE

ELEVATED HYBRIDIZATION PLATFORMS: AN IMPROVED METHOD FOR SUGARCANE HYBRIDIZATION

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Abstract

An elevated hybridization platform was designed and developed for facilitating field crosses in sugarcane. The platform consists of subunits of 13.2 m length each erected at two levelson'H' shaped tubular scaffold frames. Two such subunits areconnected to form one main unit which is placed in between two rows of sugarcane. The main units are interconnected to provide continuous mobility across the platform on a total planted area of 63.36 m^2. The platforms are positioned in two vertical levels to reach sugarcane inflorescence at different levels for effecting crosses. The platforms are in use since 2007and its efficiency over conventional lantern method of crossing was compared and found to be time, labor and resourcesaving besides providing better efficiency to hybridization programme.

Key words: Sugarcane, hybridization, elevated platforms, labor-saving

Introduction

Hybridization is the most important activity in any crop improvement programme as the genetic variability generated through recombination forms the basis forthe selection of better variants. Sugarcane breeding is more than a century old and the current breeding programmes largely rely on bi-parental crosses involving parents with complementing traits. Every year hundreds of crosses are made using commercial cultivars, genetic stocks and other germplasm sources as parents for generating the required genetic variability. In India, sugarcane hybridization is centralized at Coimbatore, Tamil Nadu State, as the optimum flowering and seed set is obtained only at this location. Every year, over 20 sugarcane research stations located in the country participate in the centralized hybridization program at the National Hybridization Garden (NHG), Coimbatore,and effect close to/nearly1000 crosses, polycrosses and selfs. Thirty to forty kg of fluff (seed) is subsequently dispatched to the participating centres where the seedlings are raised and evaluated through different clonal stages to identify superior, well adapted and location specific varieties.

Hybridization techniques

Sugarcane is a naturally cross pollinated crop and due to the bisexual nature of the flowerthere is no control over pollination under natural condition. Hence, isolation of the designated female inflorescences (arrow) to prevent pollen contamination followed by pollination using the pollenofthe preferred male parent is generally practiced to obtain the desired cross combinations. Hybridization techniques followed in different countries differ according to the local conditions and convenience. As perthe earlier practice in Java, the

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desired male and female arrows are bunchedtogether, with the male flowers surrounding the female flowers (Van Dilliewjn, 1946). In this method, pollen dehiscence occurs at the same time in both male and female flowers, hence self pollinationcannot be ruled out. Several attemptsto achieve controlled pollination in sugarcane had been tried using different methods (Venkataraman 1921, 1925, 1927).Venkataraman (1927) attempted planting the parents in adjacent plots and enclosing the male and female inflorescencesin cloth bags to ensure cross pollination.Although the method was apparently simple, positioning of the male and female flowers at different heights and synchronization of flowering were the challenges. Later such crosses with minor modifications were also tried in Java, Barbados, Mauritius and Taiwan (Stevenson 1965). The marcotting technique was developed by Venkataraman and Thomas (1926) to isolate the flowering stalks by inducing rooting of the standing canes. This facilitated hybridization using isolated flowering stalks of male and female parents and provided a better control over hybridization and is still followed in many countries. However, in most countries the Hawaiian solution technique is followed wherein the flowered stalks of both female and male parents are maintained inHawaiian solution (Heinz and Tew 1987) and are brought together in a closed cage/chamber to effect specific crosses.

In India, the lantern method of crossing is largely practiced as it was found to give better seed set. In this method cages made of aluminium frames covered with pollen-proof cloth bags are hung over the female arrows from bamboo poles erected in the field and pollinated with the pollen collected from the male arrows (Fig. 1). Male spikelets opening on the day are collected from the field every day between 4.00-5.00 am and kept under controlled conditions of temperature and humidity to induce pollen shedding. The pollen is collected from the dehisced anthers and dusted on the stigma of the opened spikelets of the female parents between6.00-8.00 am depending on the weather conditions. Dusting of pollen is continued for 6-7 days until all the spikeletsare pollinated. Seeds are collected after a minimum period of 21 days, shade dried and sown immediately or stored in -20^0 C for long term storage.

Although the above method is more natural than other methods and gives very good results in terms of seed set and reduced selfing,it is cumbersome, labor intensive and time consuming.As described above, the female flowers are protected from pollen contamination by enclosing them in a crossing lantern hung from bamboo hoisters (Fig. 1). The female arrows are positioned at 3-6m from ground level and can be reached only by using ladders. Ladders have to be shifted after every pollinationand several ladders have to be used simultaneously to complete the targeted number of pollinations within 1-2h. Hence, there are serious limitations on the number of crosses that can be effectively carried out by this method and a need for improving the method without compromising on its efficiency and relative advantages was felt. The elevated hybridization platform was developed to meet this objective.

Fig.1. Lantern method of conventional crossing

Elevated Hybridization Platforms

A new robust structure called as Elevated Hybridization Platform (EHP) was designed by Sugarcane Breeding Institute, Coimbatore, in collaboration with the Central Institute of Agricultural

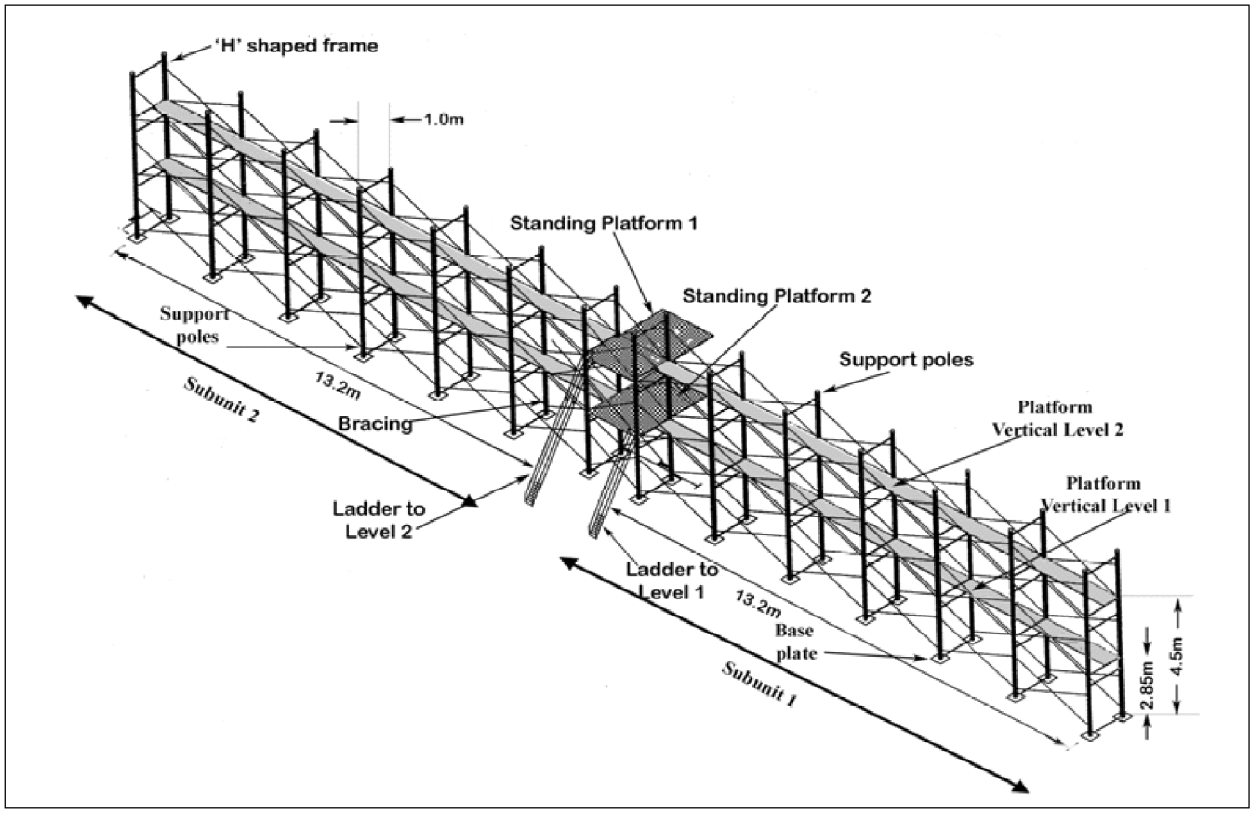

Fig.2. Isometric view of the Elevated Hybridization Platform structure

Engineering, Regional Centre, Coimbatore, to improve the efficiency of the crossing programme and to simplify the pollen collection and dusting operations (Fig.2). The EHP consisted of eight subunits of 13.2mlength, each placed between two rows of sugarcane and interconnected to facilitate movement of peopleacross the subunits/rows. Each subunit has two levels of platforms to access the arrows at different heights/levels.

Design of EHP

The EHP technically consists of two tiers of G.I.platform. These platforms are supported by H shaped 48 x 2.65mm G.I. pipe frames braced with 27 x 2.65 mm G.I. pipes to make the whole unit a scaffolded structure (Figs. 3 and 4). The H shaped G.I. pipe frames are assembled on top of each other with interlocking arrangement to make the height to 4.5m. Each main unit has 14 H shaped G.I. pipe

Fig.3. Front View of the Elevated Hybridization Platform

poles interconnected by cross bracing at an interval of 2.2m.The width of the structure would be 1.0m. The structure is erected in between two rows of plants with the row spacing of 1.2 m.A total of 11

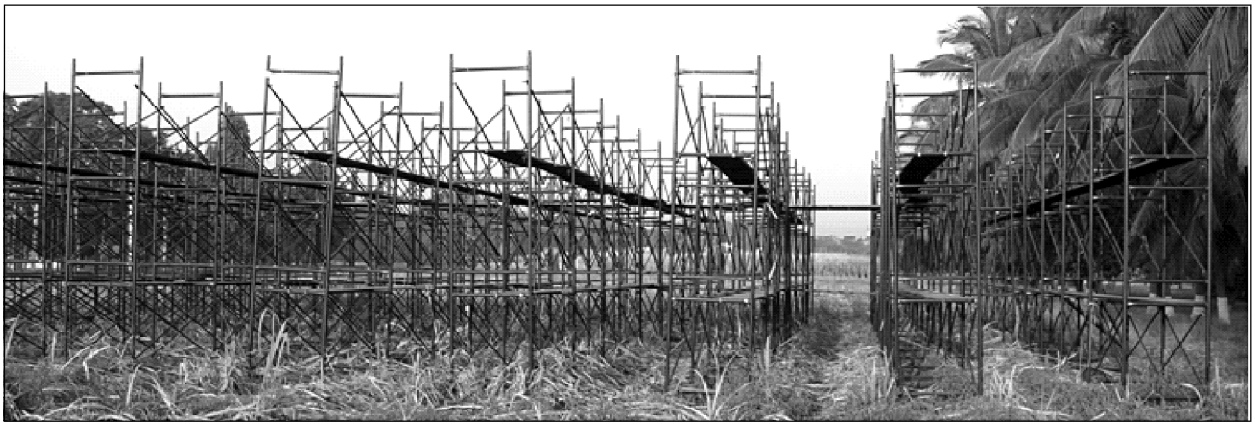

Fig. 4. Field view of the Elevated Hybridization Platform

main units were erected to cover an area of 700 m^2.

The height at which the flowers are positioned varies with the genotype. Hence the unit was fabricated to facilitate the crossing of the flowers situated in two different heights and the platforms are placed at 2.85 m and 4.5m vertical levels above ground. The unit is divided into two equal subunits each running a length of 13.2m thus covering a total length of 26.4 m. Since sugarcane parental clones areon both sides of the platform, theycan be accessed with ease and used in the crossing programme. The subunits are placed lengthwise leaving a gap of 1.5mand the gap between the two subunits is connected by a 'standing-platform'. A guard rail system runs along the scaffold structure at second working level for stability during walking. Two adjacent 'standing-platforms' are interconnected at two different heights to enable theresearcher move from one main unit to another main unit thus covering all the units without getting off every time. A 450mmwide ladder made of M.S. pipe of 48 mm diameter enables the user to reach both the vertical levels of the platform. He can move freely from one platform to another to carry out the crossing work at different heights. Similarly the EHP can be extended to adjacent rows also to any extent by placing additional units. The design of the facility is such that it is user friendly and safe. The technical specifications are given in Table 1.

Table1. Technical specification of the components of EHP

S.No	Component	Dimensions (mm)
1	M.S. base plate	300 x 300 x 6
2	G.I. H frame 1	1500 x 1000 ; 48diameter ;2.65 thickness
3	G.I. H Frame 2	1500 x 1000; 48diameter; 2.65 thickness
4	G.I. cross bracing	L = 2650; 27 diameter; 2.65 thickness
5	G.I. straight bracing	L = 1500; 48 diameter; 2.65 thickness
6	M.S. platform 1	L = 2250 ; W 450 ; 6.00 mm thick
7	M.S. plat form 2	L = 1500 ; W 450 ; 6.00 mm thick
8	M.S. adjustable platform	L = 1300 – 1400 ; W 600; 6.00 m thickness
9	M.S. hooks	For fixing cross bracing

The EHP was first installed during the crossing season of 2007. The sugarcane breeders from 21 participating centres of National fluff supply programme effectively used this facility. Initially 11 units of this structure were erected to cover 88 rows (6m length) of parental clones. EHP facility is generally used where female parents are planted and cages are erected to cover the arrows for hybridization, thus making this operation easy. During the first year of establishment of the facility at NHG, 234 crosses were made utilizing this structure. Once collection of matured fluff is completed the whole structure can be dismantled easily and stored. Since all the parts are made of standard components, the components are interchangeable making the dismantling and assembling of the unit easy. If well maintained, the structure can be used for at least 20-25 years.

Fig. 5. A scientist effecting hybridization in Elevated Hybridization Platform

Fig. 6. Scientists studying the floral biology on Elevated Hybridization Platform

Advantages of EHP

This facility was used continuously for the past seven years and was found to save labour considerably. Using EHP a breeder himself can complete most of the crossing operations like collection of male spikelets, effecting pollination and collection of matured fluff which otherwise required the support of field staff (Figs. 5 and 6). It was found that a team of a scientist and a labourer can complete 35 crosses whereas by the conventional method this would require the support of sixlabourers. This resulted in saving of 10 skilled laborers per day (70 crosses) for the 50 days crossing /year and with an average wage of Rs. 400/= per day, the total labour cost saved is around Rs.12,00,000/-during the past six years. The economic advantages in terms of coverage and costs are given in Table 2.

The EHP facility has improved the efficiency of the National Hybridization Programme by ensuring more number of crosses in limited period and improving the quality of hybridization, besides substantial saving in labour and cost/wages. This is the first time such a structure is designed and used for sugarcane in the country. This innovation has been granted the design patent (771/CHE/2011; Date of application 14/03/2010) and the product patent (Patent No. 231436 dated 14.09.2010) application is pending. Experience in the usage of this facility for the past seven years is found to be labour-saving, increased number of crosses and efficiency in effecting pollination. EHP is also recommended for use by the breeders working in tree crops, banana and other horticultural crops where the flowers are at inconvenient positions.

Table 2. Comparative performance of EHP with conventional lantern method

S.No.	Item	EHP	Conventional method
1	Number of crosses covered per day	35	15-17
2	Manpower	One scientist and one labor	One scientist and three labors for 15-17 crosses
3	Labor saving per day (70 crosses)	10	-
4	Savings in cost @ Rs. 400/day	4000	-
5	Savings of cost per annum (For 50 crossing days)	2,00,000	-
6	Extra expenditure towards erecting and dismantling of structure	30,000	-
7	Net saving	1,70,000	-

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