



## Induction and evaluation of polyploidy in some local potato varieties of Bangladesh

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### Abstract

To improve the yield potential in this present experiment colchicine were applied on sprouting bud and subsequent selected buds of Bangladeshi local potato. Colchicine treatment showed an increase effects in plant height in the variety of Hagrai, Silbilati & Lalpakri and the var. of Challisha showed no increase result besides, negative impact showed in var. Indurkani, JPR, Goforown and Shaita. Number of leaves formation was showed significant positive results in the variety of Hagrai, Shilbilati and Lalpakri showed positive while the var. of Challisha, JPR, Goforown and Shaita were showed negative result at different stage. The variety of Hagrai, Shilbilati and Lalpakri significantly showed more performance for fresh weight of plant and var. Hagrai responded the highest impact at different intervals, besides Challisha, JPR and Goforgown did not responded. The var. of Hagrai and Lalpakri at all the intervals produced highest number of tubers than rest of varieties. Hagrai and Lalpakri were showed the positive yield performance at the 70 DAPs but Silbilati and Lalpakri were showed the positive impact at the 80 DAPs. In all intervals Lalpakri obtained the best performance after Colchicine treatment. The variety Hagrai, Shilbilati and Lalpakri responded significantly in plant height, number of leaves formation and fresh weight potential of plant, though positive but no significant performance in tuber formation and fresh weight production of tubers after colchicine treatment. This might be explained that colchicine treatment enhances plant height, results in more fresh weight of plant and number of leaves, which consequently increase the number of tuber and finally increase total fresh weight of tubers of potato.

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## Introduction

Potato (*Solanum tuberosum* L.) cultivars are auto-tetraploid ( $2n=4x=48$ ) and breeding at this level is quite problematic because tetraploidy combined with inbreeding depression, makes it difficult and time-consuming to select for desirable characteristics after a sexual cross. Inter-specific hybridization is an important strategy for plant breeding, but its success depends largely on the cross combination of species. The ploidy of potato, as well as many other crops, can be reduced through anther culture (andro-genesis) or inter-specific hybridization (gyno-genesis). In the context a commonly used method to overcome hybrid sterility, chromosome doubling of the hybrid to produce an amphidiploid, involves treating meristematic cells with mitotic inhibitors such as colchicine. To overcome  $F_1$ -sterility, mitotic and meiotic polyploidisations are applied for fertile allopolyploids. Polyploids are obtained through artificial chromosome doubling by treatment of vegetative tissue with spindle inhibitors such as colchicine (Blakeslee and Avery, 1937; Emsweller, 1988) or oryzalin. Polyploidy are recognized as the most important sources of evolution and domestication of flowering plants. Colchicine has been used for doubling the number of chromosomes of many crop plants over a period of more than 50 years (Blakeslee and Avery, 1937). Colchicine is a natural alkaloid with an antimutagenic activity, obtained from the plant *Colchicum autumnale* L. (Emsweller, 1988; Van Tuyl *et al.*, 1990). When colchicine is present in a cell that is undergoing mitotic division, the chromosomes split at all points except the centromere. The main action of the colchicine is to prevent the formation of a spindle so the anaphase movement of the chromosomes does not take place and the cell fails to divide. When the daughter chromosomes finally divide, they are all included in one cell and the chromosome number is doubled. In addition to colchicines, several other chemicals are also effective in doubling the chromosome number. One of the chemicals that also inhibits mitosis activity

and is used for doubling the chromosome number in lilies is oryzalin. For doubling the chromosome number, oryzalin is used for other plants, such as potatoes (Van Tuyl *et al.*, 1992; Verhoeven *et al.*, 1990), tobacco (Sree Ramulu *et al.*, 1991). Present study was undertaken to find out effect of colchicine treatment for enhance polyploidy or chromosome doubling of potato as a modern breeding process.

## Materials and methods

### Materials

Medium size potato tubers were collected from the local market of different places of countries. The cultivars of local potato (Bangladesh) e.g. Hagrai, Shilbilati, Indurkani, Chalicha, Lalpakri, JPR, Goforgown and Shaita were used as a plant material and Colchicine and 70% ethanol were used as chemical reagent for the present investigation.

### Methods

#### *Colchicines treatment*

Hands and equipments were sterilized with 70% ethanol. When the sprout was 3-5 mm. tip 1 mm. was cut by fine razor blade. A piece of blotting paper cut previously into a small triangular shape and inserted into sprout with the help of fine knife and a pair of forceps. Drop of colchicines solution (0.05%) was applied on the projected end of the triangle continuously for two hours. A fresh drop was not applied until the previous one is dried up.

#### *Field plantation of treated tubers*

The colchicine treated tubers of 8 LPVs were randomly assigned to the inner eight lines in each replication. After plantation, tubers were covered with soil.

#### *Data collection and analysis*

For presentation of data in the figures, statistical methods were used to quantify the experimental results. Data on different parameters from different treatments were recorded after 40, 50, 60, 70 and 80

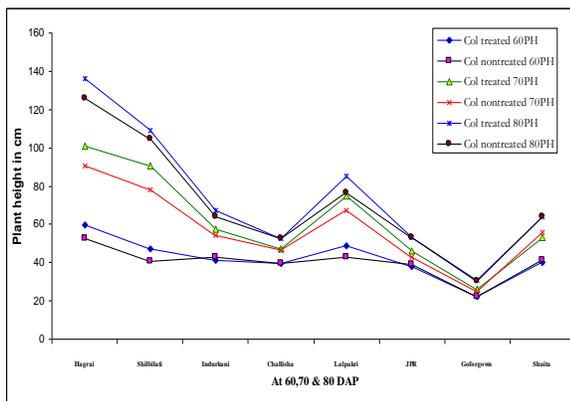
day after plantation (DAP). Standard statistical methods were used for calculating the range of variation.

## Results

### *Plant height at different growth stages*

At 60 days after transplantation (DAP) Challisha, Indurkani and JPR, show no increase in plant height. It was similar both control and treated plot in the variety Goforown and Shaita. Colchicine treatment showed an increase result in plant height only in the variety Hagrai, Silbilati & Lalpakri and the increment was statistically significant. In contrast colchicine treatment improves plant height in the variety Hagrai, Shilbilati and Lalpakri at 70 DAP, while colchicine treatment shows negative impact in plant height in var. Indurkani, JPR, Goforown and Shaita with a little taller plant in the control plot. It interesting to note that, the impact was statistically significant shown in the Graph 1. At the end of 80 DAPs the effect of colchicine shows significant raising of plant height again in the variety Hagrai, Shilbilati and Lalpakri and no other variety responded positively in treatments of plant height even though plant height in some varieties lower to some extend.

**Graph 1.** Effect of colchicines treatment on plant height (cm) at different days of local potato cultivars.

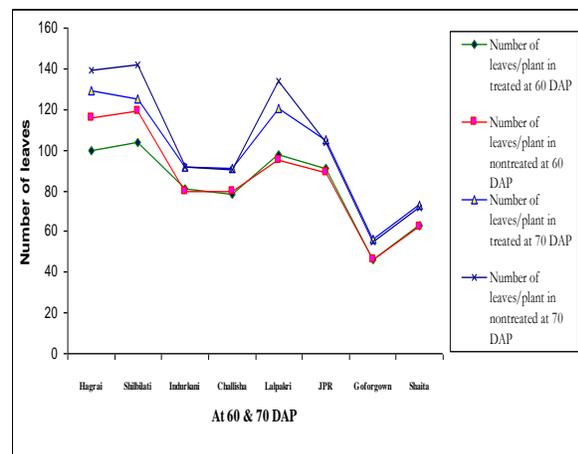


### *Number of leaves formation at different growth stages*

Number of leaves formation at 60 DAPs showed significant positive results in colchicine treatment

compares to control plot and variety of Hagrai and Shilbilati. Observation in number of leaves other varieties were showed the result negative. To the contrasts colchicine treatment increases the number of leaves from 100 to 116 and 104 to 119 in the variety Hagrai and Shilbilati respectively compare to control one at 60 DAPs. Number of leaves formation after 70 days of transplantation, the var. Hagrai, Shilbilati and Lalpakri were showed the best performer in respect to non treated plot and the performance was significant. Other varieties under observation indicated no or negative effect on the number of leaves formation. Conversely, some variety like Challisha, JPR, Goforgown and Shaita emerged lower leaves after colchicine treatment which is shown in the Graph 2.

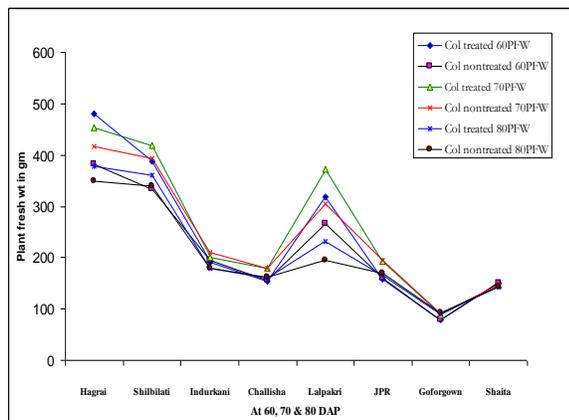
**Graph 2.** Effect of colchicines treatment on leaves formation at different days local potato cultivars.



### *Fresh weight of plants at different growth stages*

The impact of colchicine on fresh weight of plant was studied, as fresh weight of plant is an important attribute in carbon distribution, which in term contributes to the yield of tuber. At all the three intervals, the variety Hagrai, Shilbilati and Lalpakri showed more fresh weight of plant the result was statically significan, while the variety Hagrai responded with heighest fresh weight of plant at 60, 70 and 80 DAPs, while Challisha, JPR and Goforgown did not responded to the application of colchicine for fresh weight of plant present in the Graph 3.

**Graph 3.** Effect of colchicines treatment on plant fresh weight (gm) at different days of local potato cultivars.

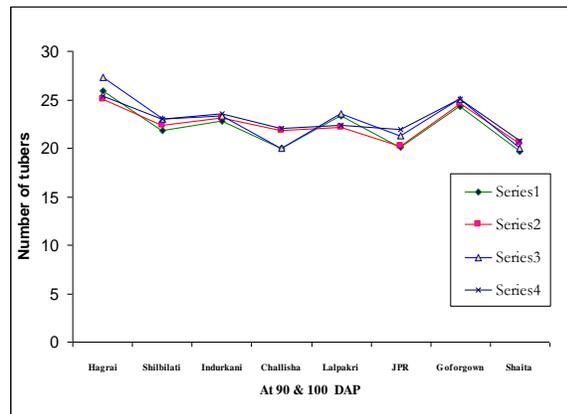


*Number of tubers formation at different growth stages*

Effect of colchicine on number of tuber at several DAP were also studied like the effect of colchicine on the fresh weight of plant. The variety Hagrai and Lalpakri at all the intervals produced higher number of tubers, which explained that increased fresh weight of plant produced more number of tubers due to highest assimilation and distribution of photosynthesis but the results was statistically insignificant that is present in Graph 4. Other varieties have no correlation between fresh weight of plant and number of tuber per plant.

variation, comprising of mutation coupled with or without hybridization between mutant forms, polyploidy put in to the evaluation of crop species. Polyploidy is a key facilitator of speciation and evolution in plants and to a minor level in animals is associated with intra and inter-specific hybridization (Levin, 1983).

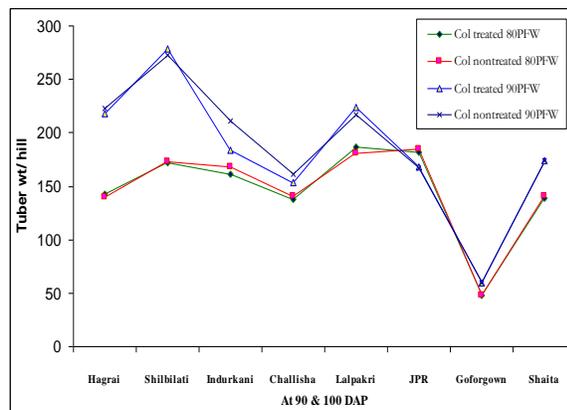
**Graph 4.** Effect of colchicines treatment on tuber formation at different days of local potato cultivars.



*Yield of lpus at different growth stages*

Colchicine treatment (at the rate of 0.05%) increases the yield of potato in the variety Hagrai and Lalpakri at primary data of harvest at 70 DAPs, while late at 80 DAPs variety Shilbilati and Lalpakri yielded more. No other significant difference in different varieties and date of harvesting which is shown in the graph 5.

**Graph 5.** Effect of colchicines treatment on tuber weight per hill at different days of local potato cultivars.



**Discussion**

Plant breeding plays considerable role for the improvement of the characteristics of the plants which is required for the development of the new variety effectively and economically. Alongside of Mendelian

Polyploidy is an interesting trend in plants that has provided an important pathway for evolution and speciation (Bennett, 2004). Kirhara (1951) also reported that the leaves of tetraploid plants were large, thick and dark green than the diploid plants. Similarly, broader leaves in *Citrus* (Jaskani *et al.*,

1996), higher ratio of leaf width to length in *Alocasia* (Thao *et al.*, 2003), and broader and thicker leaves in *B. globosa* (Rose *et al.*, 2000) have been reported in tetraploid genotypes. Similarly agronomic performances of 15 diploid clones were studied by Rowe (1967) with their colchicine doubled counterparts and it was observed that at the same time as clones reacted differently to doubling, the tetraploids were generally inferior. Moreover, Stebbins (1950) noticed that polyploids showed better performances not only in potato, but also in some other crops including coffee, banana, peanut, tobacco, wheat, oats, sugarcane, plum, loganberry and strawberry. After observing the polyploidy nature of different crop plant, the bigger size and vigour of the same in many cases, plant breeders are on track in getting interest in the artificial induction of polyploidy.

### Conclusion

In this present experiment mostly optimized a comparative picture of various performances between treated and non treated potato plant in the field condition. The study on Plant height, number of leaves formation per plant, fresh weight of plant, tuber formation and fresh weight impact of tubers revealed that with the application of colchicine. In all intervals Lalpakri obtained the best of yield performance and several times the variety of JPR, Challisha, Shaita, Indurkani were showed negative or no response for different parameters after Colchicine treatment. The variety Hagrai, Shilbilati and Lalpakri responded significantly positive in plant height, number of leaves formation and fresh weighty potential of plant but no significant increase result in tuber formation and fresh weight production of tubers. This might be explained that colchicine treatment enhance plant height, which increase number of leaves and fresh weight of plant that was consequently increase the number of tubers per plant, finally resulting more fresh weight of tubers. In this present study was optimized no any morphological

appearance, which indicates the change of chromosomal character sticks, that is absent autotetraploid in all varieties of potato. Therefore, alternative methods have to be done for change of chromosomal character sticks and polyploidy induction for varietal improvement of potato.

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