FINDING OF SUITABLE PLANTING DATE OF TPS PARENTS FOR HYBRID SEED PRODUCTION IN NORTHERN AREAS OF PAKISTAN

Nizamuddin*, Bushra Mirza* and Maqsood Qamar**

ABSTRACT
Two years research was carried out to find out the suitable planting time for hybrid seed production in Gilgit. Four female TPS parents viz., Atzimba, LT-8, MF-I and MF-II and one male parent TPS-67 were planted in three planting dates. Number of inflorescence per plant and number of flowers per inflorescence were more in TPS lines Atzimba and LT-8 planted at first and second planting dates. Similarly, flower initiation was earlier in Atzimba and LT-8 at second planting date than the first and third planting date, whereas flowering initiation in MF-1, MF-II and TPS-67 was not affected by different planting dates. More number of berries per plant was produced by Atzimba and LT-8. MF-I and MF-II produced lower number of berries per plant. Atzimba and MF-II produced more number of seeds per berry at planting date first and second whereas, LT-8 produced maximum number of seeds at planting date first. Atzimba produced higher 1000-seed weight at second planting date whereas; remaining TPS parents produced higher number of 1000-seed weight at first planting date.

Keywords: Hybrid, Pakistan, Solanum Tuberosum L., True Potato Seed, TPS

INTRODUCTION
Non-availability of certified seed during planting season at reasonable prices is the main constraints of low potato yield in developing countries. Poor and resource less farmers cannot purchase costly seeds. In some developed countries, some sophisticated methods of seed multiplication are adopted like tissue culture. This is a costly method and most of the farmers cannot afford to buy such seed. The demand for viable alternative like true potato seed (TPS) to the costly and often unavailable seed tubers for growing potatoes is increasing in the country.

True potato seed (TPS) is easier to store, transport and easily manageable as compared to bulky and costly tubers. To plant one hectare area about 2.5 tons of seed tubers are required whereas, only about 100 grams of TPS fulfills the same requirement. Moreover, TPS is free from most of the viruses and soil borne diseases. Keeping in view the above facts a study has been conducted to find out suitable period of TPS parents for hybrid seed production in northern areas of Gilgit in Pakistan.

MATERIALS AND METHODS
An experiment was conducted during the two spring seasons of 2004-05 to find out suitable time for TPS production at Directorate of Agriculture, Gilgit. The planting material consisted of four female TPS parents viz. Atzimba, LT-8-MF-I, MF-II and one male parent namely TPS-67. Three planting dates i.e. February 8, 18 and 28 with ten days of interval were followed. Each plot of 1.5 x 3 m consisted of three lines of female parents planted at 50 x 20 cm spacing in randomized complete block design with three replications. Male parent was planted 30 days before planting of female parents to get uniform synchronization.

Emasculation was done in the evening. A flower bud that would open in the next morning was selected and emasculated and rest of the buds removed leaving 4-6 buds. Pollination was carried out in the morning. The selected flower was gently pushed apart along the sutures and the five stamens were removed with fine pointed forceps. The emasculated flowers were then bagged. Fully matured anthers from male parent were collected in a petri dish and pollen dusted on the stigma with the help of a brush.

Data was recorded on five randomly selected female plants on ten characters like plant height, number of branches per plant, days taken to flower initiation, number of inflorescence per plant, number of flowers per inflorescence, percent berries settings, total berries per plant, number of seeds per berry, 100 seed weight and total weight of TPS per plant. Data was analyzed statistically applying the analysis of variance technique (Steel and Torrie, 1980) by using MSTATC software.

RESULTS AND DISCUSSION
Number of Braches per Plant
Analysis of variance for number of branches per plant showed that except the interaction between TPS parents and planting date all types of interactions were non-significant (Table 1). The TPS parent Atzimba produced the lowest number of branches per plant (27) at first planting date,
whereas, it produced significantly higher number of branches per plant at 2\textsuperscript{nd} and 3\textsuperscript{rd} planting date. The TPS Patent LT-8 yielded significantly higher number of branches per plant (45) (Fig.1) on crops planted at first planting date, whereas number of branches per plant produced by it on the crop planted at later dates was non-significantly different from other TPS parents. MF-II produced significantly higher number of branches per plant at first planting date than third planting date. The number of branches per plant was non-significant among different planting dates in MF-I and MF-II. These findings suggest that the effect of planting dates on number of branches per plant is genotype/variety specific (Fig.1). Main effect of year and planting date on number of branches per plant was not significant (Table 2), however, Effect of TPS Parents was highly significant for number of branches per plant. Beakema and Zaag (1990) reported significant difference among the genotypes for number of branches per plant. They also argued that Variety/genotype is one of factors that affect number of branches/stem arising from a seed.

**Plant Height (cm)**

All interactions except the interaction between year and TPS Patents as well as the main effect of planting date on height of plant were non significant. Farooq (2005) and Malik (1995) reported non-significant effect of year on plant height. However, they found significant effect of planting date on plant height. In their study, the interval between planting date and temperature fluctuation was greater than the present study. This temperature variation might have affected the plant height. The main effect of year and TPS parents was significant. The TPS parents Atzimba (71.07 cm) and LT-8 (74.47) were at par, which showed the greatest height whereas MF-I and MF-II produced the shortest plants (Table 2). Farooq (2005), Bhatia, et al. (1992), Batra, et al. (1992) and Verma and Singh (1995) reported significant differences among parental lines for plant height. There were non-significant differences among the crops planted at different dates for plant height (Table 1). The crop planted at first planting date produced taller plants than the crop planted at later date (Table 2). Farooq (2005) also reported significant effect of planting date on plant height of TPS parents. These findings support the results of present study.

**Number of Inflorescence per Plant**

All types of interaction and main effect of planting date and TPS parents were highly significant (Table 2). Effect of TPS parent x planting date interaction on number of inflorescence per plant is represented in Fig.2. The TPS parents MF-I and MF-II performed significantly more number of inflorescence per plant whereas, LT-8 produced better at second planting date. For remaining TPS parents, the effect of planting date on number of inflorescence per plant was non-significant.

The variation among the TPS parents for inflorescence per plant was significant (Table 2). Atzimba and LT-8 were at par and produced the highest number of inflorescence per plant. Male parent TPS-67 produced the lowest number of inflorescence per plant. Number of inflorescence per plant (6.56) was decreased in crop planted at 28\textsuperscript{th} February while crop planted at February 8\textsuperscript{th} and 18\textsuperscript{th} produced similar number of inflorescence per plant (7.55 and 7.52, respectively). Similar findings on date of planting and TPS parents were reported by Patel et al. (2000), where interaction between TPS parents and planting date and main effect of TPS parents and planting date on number of inflorescence per plant were significant. This result is also supported by Pande and Singh (2000) who also reported significant effect of planting date on number of inflorescence per plant.

**Number of Flowers per Inflorescence**

Except the TPS parents x planting date interaction all types of interactions and main effect have significant effect on number of flowers per inflorescence (Table 2). Fig.3 presents TPS Parent x year interaction. In first year (2004), MF-II produced significantly lower number of flowers per inflorescence than Atzimba LT-8 and TPS-67 whereas, in second year (2005), it is at par with Atzimba, LT-8 and TPS-67 in production of flowers per inflorescence. Number of flowers per inflorescence of crop planted at first planting date (9.52) and second planting date (9.26) was significantly higher than the number of flowers per inflorescence (8.32) in the crop planted on third planting dates (Table 2). Atzimba, LT-8 and TPS-67 were at par for production of flowers per inflorescence (Table 2) while MF-I produced the lowest number of flowers per inflorescence. Pande and Singh (2000) have also reported significant effect of planting date on production of flowers per inflorescence in TPS parents. Similarly, Upadhya (1983) has found significant genetic variability among 38 TPS genotypes that indicated substantial additive genetic effects and viewed that the selection can be effective for number of flowers per inflorescence.

**Days to Flower Initiation**

The interaction between TPS parents and planting date as well as the interaction between TPS parents and the year was highly significant (Table 2). TPS parents specific effect of planting date and year on days to flower initiation shown in Fig.4. Days to flower initiation on MF-I and MF-II and TPS-67 was not affected by different planting dates,
whereas, flowering initiation was enhanced in Atzimba and LT-8 at second planting date. Flowering initiation was significantly earlier in the crop planted on second planting date and late planting date delayed the flowering initiation (Table 1). Turner and Ewing (1988), Pande and Singh (2000) reported significant effect of planting date on days to flower initiation. They reported that the planting date that provides conducive minimum temperature up to berry setting (12°C) favours early flowering.

**Number of Berries per Plant**
Total Berries per plant (self pollinated and cross pollinated) was analyzed. The interaction between planting date and TPS parents as well as between year and planting date and main effect of planting date on number of berries per plant was non significant (Table 2). Year x TPS Parent interaction and main effect of genotypes and year was highly significant (Table 1). TPS parent x year interaction is shown in Fig.5. Comparison of TPS parents for number of berries per plant showed that the parents can be divided into two distinct groups Atzimba and LT-8 are non significantly different from each other while MF-I and MF-II have statistically similar number of berries per plant. Dayal et al. (1984) have also reported similar effect. They found a significant effect of genotypes on number of berries per plant.

**Percentage of Berries Setting**
Analysis of variance for percentage of berries setting in crosses revealed that except main effect of TPS parents all types of interaction and main effect were non-significant (Table 2). Berries setting percentage in TPS parents ranged from 21.21% in MF-II to 74.26% in Atzimba (Table 1). Atzimba and LT-8 were non-significantly different from each other. Similarly MF-I and MF-II have statistically similar number of berries per plant. Dayal et al. (1984) have also reported similar effect. They found a significant effect of genotypes on number of berries per plant.

These findings are in accordance with those of Patel et al. (2000) and Luthra et al. (2000) who observed significant difference among TPS Parents for percent berries settings. In this study the planting time did not affect the percent berry setting (Table 2). However in earlier studies Patel et al. (2000) and Pandey and Singh (1999) observed the effect of planting date on berry settings. In this experiment non-significant effect of planting time might be due to shorter interval between the planting dates.

**Number of Seeds per Berry**
The difference among the planting dates, TPS Parents and year for number of seeds per berry was highly significant (Table 2). The interaction between TPS parents and planting date as well as between TPS parents and year was significant. TPS Parents specific effect of year and planting date on number of seeds per berry is represented in Fig.6 and 7, respectively. Atzimba and MF-II produced similar number of seeds per berry at first and second planting date while LT-8 showed maximum production of seed at first planting date (Fig.7). Planting date did not affect the number of seeds per berry on MF-I.

Comparison among TPS parents showed that the Atzimba and LT-8 did not differ significantly from each other for production of seed/berry and produced significantly higher seeds per berry than MF-I and MF-II which are at par with each other (Table 1). The crop planted at 8th February and 18th February yield higher number of seeds/berry (112.9, 105.6 respectively) than crop planted at 28th February (86.3) (Table 1). Similar findings were reported by Pandey and Singh (1999) and Patel et al. (2000) on TPS parents and planting date. They observed significant interaction between genotype and planting date and main effect of genotype and planting date on number of seed per berry. Pandey and Gupta (1995) also found variation among genotype for number of seeds per berry.

**100-Seed Weight (mg)**
Except the main effect of year all interactions as well as main effects were significant on 100 seed weight (Table 1). TPS parents’ specific effect of year and planting date on 100-seed weight is presented in Fig.8 and 9. Atzimba produced more 100 seed weight at crop planted at 18th February while remaining three TPS parents have more seed weight at first planting date. In year 2004, there was non-significant difference between Atzimba and LT-8 while in year 2005, these TPS parents showed significant differences for 100 seed weight (Fig.9). 100 seed weight was the lowest in third planting date, while there was non-significant difference in 100 seed weight between first and second planting dates (Table 2).

Differences among the TPS parents for 100 seed weight were significant (Table 2). MF-I showed the highest 100 seed weight (64.78 mg) while MF-II had the lowest 100 seed weight (53.61 mg). Variation in seed weight was also observed by Dayal et al. (1984) and Luthra et al. (2000) in TPS genotypes.

The TPS parents poor in berry setting, poor seed setting and having lower 100 TPS seed weight have little importance. However, those producing moderate to good berry setting, seed setting and 100 TPS seed weight can be exploited for breeding and TPS production (Pandey and Gupta (1995). Luthra et al. (2000) suggested the genotypes for
production of TPS should be selected on the basis of berry setting, seed setting. Dayal et al. (1984) and Luthra (2000) suggested that initial selection of a suitable genotype might be based on 100 TPS seed weight.

Total TPS weight per plant (mg)

Three ways interaction and interaction between planting date and TPS parents was highly significant for per plant total true potato seed weight (Table 2). TPS parent specific effect of planting date on total TPS weight per plant is represented in Fig.10. Effect of planting date on Atzimba and MF-II was non-significant whereas LT-8 produced lower quantity of TPS per plant at third planting date while MF-I showed the lowest TPS weight per plant at first planting date. Patel et al. (2000) also observed genotype specific effect of planting date on per plant TPS production. In this study the effect of planting date on TPS production was non significant (Table-2) while main effect of year on per plant TPS weight was highly significant. Variation among TPS Parents was also highly significant. Data in this study shows two distinct groups of TPS parents on the basis of total TPS weight per plant (Table 2). Atzimba and LT-8 were at par with each other and produced higher quantity of TPS per plant than MF-1 and MF-II, which were also at par with each other. The results here are in accordance with those of Patel et al. (2000) who also reported significant effect of genotype on TPS production.
Fig. 1. *Effect of sowing dates on number of branches per plant*

Fig. 2. *Effect of sowing dates on number of inflorescence per plant of TPS parents*
Fig. 3. Year x variety interaction on number of flower/inflorescence of TPS parents during two years.

Fig. 4. Effect of sowing dates on days to flower initiation of TPS parents.

Fig. 5. Year x variety interaction on number of berries per plant of TPS parents during two years.
Fig. 6. Year x variety interaction on number of seeds per berry of TPS parents during two years

Fig. 7. Effect of sowing dates on number of seeds/berry of TPS parents

Fig. 8. Year x variety interaction on 100 seed weight (g) of TPS parents during two years
Fig. 9. Effect of sowing dates on 100 seed weight (mg)

Fig. 10. Effect of sowing dates on total TPS weight per plant
### Table I. Effect of sowing dates on TPS parents for hybrid seed production during 2004 and 2005

<table>
<thead>
<tr>
<th></th>
<th>No. Of branches per plant</th>
<th>Plant height (cm)</th>
<th>No. Of inflorescence/plant</th>
<th>No. Of flowers/inflorescence</th>
<th>Days to flower initiation</th>
<th>No. Of berries/plant</th>
<th>% Of berries formation</th>
<th>No. Of seeds/berry</th>
<th>100 seed weight (mg)</th>
<th>Total TPS weight plant (mg)</th>
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</thead>
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<td><strong>Years</strong></td>
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<tr>
<td>2004</td>
<td>30.82 a</td>
<td>88.18 a</td>
<td>7.38 a</td>
<td>7.81 b</td>
<td>80.93 a</td>
<td>6.80 b</td>
<td>44.32 a</td>
<td>94.75 b</td>
<td>60.78 a</td>
<td>1.92 b</td>
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<td>2005</td>
<td>39.89 a</td>
<td>63.23 b</td>
<td>7.04 a</td>
<td>10.27 a</td>
<td>74.44 b</td>
<td>8.86 a</td>
<td>46.43 a</td>
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<td>ATZIMBA</td>
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<td>71.96 a</td>
<td>8.97 a</td>
<td>9.65 a</td>
<td>62.66 c</td>
<td>10.79 a</td>
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<td>2.62 a</td>
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<td>9.85 a</td>
<td>62.05 c</td>
<td>11.24 a</td>
<td>70.11 a</td>
<td>128.47 a</td>
<td>62.13 b</td>
<td>2.99 a</td>
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<td>58.74 c</td>
<td>6.73 b</td>
<td>7.11 c</td>
<td>79.77 b</td>
<td>4.23 b</td>
<td>15.92 b</td>
<td>73.01 b</td>
<td>64.78 a</td>
<td>1.86 b</td>
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<td>MF-II</td>
<td>27.33 a</td>
<td>59.51 c</td>
<td>6.25 b</td>
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<td>80.77 b</td>
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<td>53.61 c</td>
<td>1.91 b</td>
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<td>TPS-67</td>
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<td>4.88 c</td>
<td>9.84 a</td>
<td>103.16a</td>
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<td>1.424</td>
<td>0.8588</td>
<td>3.196</td>
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<td>0.3067</td>
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<td>08 Feb</td>
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<td>9.55 a</td>
<td>78.63 a</td>
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<td>45.28 ns</td>
<td>112.91 a</td>
<td>61.28 a</td>
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<tr>
<td>18 Feb</td>
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<td>7.52 a</td>
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<td>42.48</td>
<td>105.61 a</td>
<td>61.36 a</td>
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<td>NS</td>
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<td>8.62</td>
<td>1.069</td>
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* Values in the column followed by same letters did not differ significantly at $p = 0.05$
Table II. Mean square values of TPS parents for hybrid seed production during 2004 and 2005

<table>
<thead>
<tr>
<th>S.O.V.</th>
<th>df</th>
<th>No. of branches/plant</th>
<th>Plant height (cm)</th>
<th>No. of inflorescence/plant</th>
<th>No. of flowers/inflorescence</th>
<th>Days to flower initiation</th>
<th>No. of berries/plant</th>
<th>% Of berries formation</th>
<th>No. of seeds/berry</th>
<th>100 seed weight</th>
<th>Total TPS weight/plant</th>
</tr>
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<tbody>
<tr>
<td>Year (factor – A)</td>
<td>1</td>
<td>19.600 ns</td>
<td>551.554*</td>
<td>2.704 ns</td>
<td>135.915**</td>
<td>947.378**</td>
<td>76.056*</td>
<td>80.645 ns</td>
<td>3392.134</td>
<td>13.005 ns</td>
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<tr>
<td>TPS parent (factor – B)</td>
<td>4</td>
<td>655.350*</td>
<td>858.311*</td>
<td>61.202**</td>
<td>24.688**</td>
<td>5098.906**</td>
<td>245.913**</td>
<td>17383.928*</td>
<td>20148.58</td>
<td>410.931*</td>
<td>2.490**</td>
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<td>A x B</td>
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<td>48.687*</td>
<td>22.794*</td>
<td>8.063*</td>
<td>242.350**</td>
<td>47.381*</td>
<td>68.881 ns</td>
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<td>Error</td>
<td>18</td>
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<td>12.645 ns</td>
<td>4.137 ns</td>
<td>1.504 ns</td>
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<td>12.497*</td>
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<td>B x C</td>
<td>8</td>
<td>348.383*</td>
<td>10.981 ns</td>
<td>7.933**</td>
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<td>20.922**</td>
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<td>69.664 ns</td>
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<td>19.402*</td>
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<td>4.499*</td>
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<td>144.225 ns</td>
<td>125.571</td>
<td>12.157 ns</td>
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* Significant, ** Highly Significant, NS Non-Significant
REFERENCES


