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An Analysis of the Potential of True Potato Seeds Production in Northern Areas of Pakistan

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Abstract:

The production of potato per hectare in Pakistan is very low as compared to the developed countries of the world. The main reasons behind this are the unavailability of proper seeds and the use of conventional production system. One solution to these problems is the use of botanical seeds or true seeds instead of conventional propagation from seed tubers. True potato seed technology has a great potential in supplementing the availability of healthy propagules for potato production and high yielding homogenous population. With this point of view research activities on TPS were carried out to identify TPS families giving desirable yield and tube characteristics under Chitral conditions. Two potato genotypes Desiree and Cardinal were used in the Study. Significantly successful results were obtained from the current study. The genotype Desiree gives best result in terms of True Seeds as compared to Cardinal. Desiree also shows best result for other parameters as well except plant height, Leaves per plant and Pollen Viability. Both varieties were found to be less vulnerable to any Viral, bacterial or fungal disease. Awareness and utilization of the potential of True Potato Seeds Production in Northern Areas of Pakistan is strongly recommended for obtaining higher production of quality potato.

Key words: True potato Seeds, parameter, Plant height, Pollen Viability.

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Introduction

The potato is world third's most important food crop after wheat and rice with 309 million tones fresh weight of tubers produced in 2007 from 18.5 million hectares of land (http://faostat.fao.org). Half of the potato production in 2007 (150 million tons) was in Asia, Africa, and Latin America. China (56 million tons, down from 71 in 2005) is the number one potato producer in the world, Russian federation the second, India third and USA is the fourth one. More than three billion people consume potatoes (CGIAR 2001). During the past decades, potato has emerged as high yielding cash crop in Pakistan. It has gained economic importance in the country and there is rapid increase in area under its cultivation. Area was increased from 3,000 hectares in 1947 to 105,200 hectares in 2002 (MINFAL 2002). However , the average yield of 16.37 tons per hectare is low as compared to developed potato growing countries (New Zealand, Netherland, France and Germany) with an average yield of 50.00, 45.87, 41.81 and 40.45 ton /ha respectively (FAO 2002). Imported seed costs 50-60% of the total cost of production, which is beyond the purchasing power of the small farmers (Nizam *et al.* 2005). A conventional potato production system in Pakistan, based on seed tubers, have many disadvantages. The lowest yield of potato in Pakistan is due to viral and other pathogenic diseases of potato crops (Falloon *et al.* 1998). One solution to these problems is the use of botanical seeds or true seed instead of conventional propagation from seed tubers (Schmiediche, 1997). CGIAR, 2001 suggest a major boost in potato production system that utilizes hybrid true potato seeds (TPS) as the planting material. True potato seed technology has a great potential in supplementing the availability of healthy propagules for potato production and high yielding homogenous population (Martinetti 1987). True potato seed technology is alternative or supplement to traditional seed tubers (Berrios 1995). It has

been confirmed that the mini tubers produced after raising TPS nursery were almost healthy having great potential for production of commercial crop (Iqbal and Khan 2003).

High quality first generation seedling tubers (F1C1) can be obtained by seeding TPS in the nursery at high plant density (Nayar 1992, Wiersema 1985, Wiersema 1986) or by planting seedlings directly in the field. In small nursery beds, the adverse conditions can be managed well than in the field. Seedling tubers above 1 g size can be used for potato production (Adhikari and Rai 2004). Wiersema (1986) reported that the yield increases were significant with >5 g size tubers. It has been widely reported that both growth and yield of individual stems are largely dependent on the seed tuber size (Allen and Scoot 1980, Wiersema 1986).

Malagamba and Monares (1988) found that TPS technology suitable for small farmers in developing countries have no access to good quality seed tubers due to high prices. It has the capacity to produce more energy and protein per unit (land) than any other single food crop (Bajaj 1987). With this point of view research activities on TPS were carried out to identify TPS families giving desirable yield and tube characteristics under Chitral conditions.

Materials and Methods

Seed tubers of two potato genotypes Desiree and Cardinal were collected from Aga khan Rural Support program (AKRSP) and were planted at Chitral (6000 feet above sea level) on 15th of April 2011. The experiment was laid out in an RCB design, replicated three times in open field having two rows of 100 cm row to row spacing and 25 cm plant to plant spacing. Fertilizer dose of 225-125-125 NPK kg/h^{-1} in the form of Urea, Single Super phosphate (SSP) and Sulphate of potash (SOP) was applied. Phosphatic and Potash fertilizers were applied at the time of seedbed preparation, while Nitrogenous

fertilizer was applied in two split doses after 30 and 60 days of planting. Crop management practices and crop protection plan were taken to raise better crop. Barriers were collected at maturity from open pollinated flowers. TPS were extracted after softening the berries in water. The seeds were air-dried in glass for a week.

Data Collection

1. **Days of Flowering**: Days to flowering were recorded from the date of planting to the appearance of first flower within the experimented plants.
2. **Plant Height**: Plant biomass is directly correlated with plant height. Plant with Large biomass has the ability of higher photosynthesis and their translocation resulting into higher yield of crops. Plant height was measured of randomly selected four plants.
3. **Number of leaves plant**$^{-1:}$ The no of leaves plant^{-1} data were recorded by counting the total no of leaves produced in four randomly selected plants in each plot and there means computed.
4. **Pollen Viability**: Fifteen freshly opened flowers were collected. Separated the anthers and placed in petri plate and covered for half an hour. Collected anthers and stained with acetocarmine glycerol in slide. The total no of pollen grains and fully stained pollen grains were counted under microscope and calculated percentile viability using following formula.
   Pollen viability (%) = Total no of fully stained pollen grains / Total no pollen grains
5. **Number of flower Per Plant**: The no of flowers plant^{-1} data were recorded by counting the total no of flowers produced in four randomly selected plants in each plot and there means computed

6. **Number of Berries**: The total no of berries produced in seven randomly selected plants were counted and there means were computed.
7. **Beery diameter**: The diameter of randomly selected seven matured berries was measured in centimeter.
8. **Average Berry weight (g)**: The average weight of seven mature berries were measured
9. **Number of Seeds Berry^{-1}**: At maturity Berries were collected and softened at room temperature. Seeds were extracted from four randomly selected berries counted and computed average number of seeds
10. **Seed weight (mg)**: After drying hundred seeds were weighed and data were recorded in mg.

Results

Sustaining potato cultivation in Pakistan depends upon development of good quality seeds and its supply at affordable prices. Focusing on TPS as the source of healthy planting material, an experiment was conducted for the evaluation and use of true potato seed for crop production in Chitral (Figure 1).

Berries containing TPS of Desiree

Cross section of Berry

Figure 1 picture of Barry and True Potato Seeds of Desiree variety under Cold but Long day conditions

Plant Height

Plant biomass is directly correlated with plant height. Plant with Large biomass has the ability of higher photosynthesis and their translocation resulting into higher yield of crops. The data pertaining to Plant heights are depicted in table 1.1 which showed significant level of differences between the two genotypes of potatoes. Cardinal was the taller (64.2cm) than desiree (58.5cm).

Leaves plant-1

Statistical analysis showed the data for Leaves plant-1 showed significant variation between Desiree and cardinal.

Days to flowering

Statistical analysis of the data for the days to flowering revealed no significant variation between Desiree and cardinal.

Days to flower completion

Desiree and Cardinal showed significant variation at 1% probability level for the number of days to flower completion. Genotype Cardinal completed flower earlier and took 85.5 days while Desiree took 92.2 for flower completion.

Flowering Duration

Analysis of variance showed significant variation for flowering duration. The genotype Desiree had the max flowering duration of 30.2 days while cardinal takes 21.4 days.

Pollen Viability

Analysis of variance showed a significant variation between Desiree and Cardinal for pollen viability. The genotype cardinal had the maximum pollen viability of 32.4% while 27.5% of pollen viability was observed in Desiree.

Number of flower plant^{-1}

A total of average of 43.2 number of flower plant^{-1} was observed in Desiree while the genotype cardinal showed a total of 38.8 number of flower plant^{-1}.

Number of berry plant^{-1}

The two potato genotypes Desiree and cardinal showed significant level of variation for the number of berry plant^{-1}. The highest number of berry plant^{-1} (10.2) was observed in Desiree and that of 7.3 number of berry plant^{-1} was observed in Cardinal.

Berry Diameter

Analysis of variance showed no significant level of variation between Desiree and cardinal diameter of berry. The average berry of Desire had 2.3cm diameter while cardinal berry present an average diameter of 2.2cm.

Average berry weight

Analysis of variance fails to show a significant level of variation between Desiree and Cardinal. Desiree had a mass of 4.2g while Cardinal genotype had berry with 2.25g weight.

Number of seeds berry^{-1}

Desiree and Cardinal Genotypes showed significant level of variation for number of seeds berry^{-1}. Genotype Desiree berry contained average of 95 number of seeds berry^{-1}. Similarly Cardinal's berry had an average of 84.8 number of seeds berry^{-1}.

100 seed weight

No significant variability was observed between Desiree and Cardinal for 100 seed weight. The genotype Desiree showed of 55g for 100 seed weight while Cardinal had 54.5g for 100 seed weight.

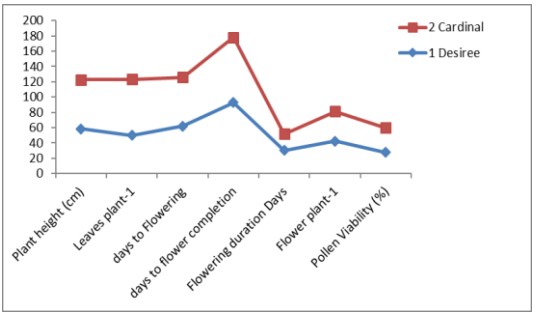

Fig.1 Means for Plant height, Leaves plant^{-1}, days to Flowering, days to flower completion, Flowering duration flower plant^{-1} and Pollen Viability of two Desiree and Cardinal Varieties planted at Chitral.

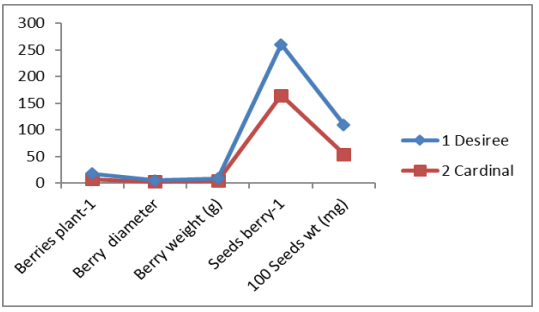

Fig. 2 Means for Berries plant^{-1}, Berry diameter, Av. Berry weight, Seeds Berry-1 and100 Seeds weight of two Desiree and Cardinal Varieties planted at Chitral.

Discussion

A conventional potato production system in Pakistan has many disadvantages. Conventionally propagated crop is highly vulnerable to biotic and abiotic stresses. Physiological problems such as post-harvest handling, numerous factors are responsible for low productivity of potato in Pakistan, and the major one is the unavailability of certified seeds at reasonable prices. More than 95% of seed requirement is met from local tubers that suffers from more than 20 soil and tuber borne fungal, viral, bacterial, phytoplasmic and non-parasitic diseases (Bhutta and Bhatti 2002). Mirza (1987) reported that 13% yield

of the crop is reduced by 5% infected tubers by potato leaf roll virus. Delober *et al.* (1994) stated that poor seed quality is the main important of low potato productivity. Formal certified seed tuber production is limited and faces technical, economical and managerial problems (Wooster and Hussain 1995). The statement of high production in potato as compare to other cereal was cited by (APCOM). TPS is attractive technological alternative to overcome the above mentioned weakness of clonally propagated tubers (Chilver *et al.* 1997). True potato seeds technology offers alternative to conventional seed tubers (Berrios 1995). Tuber transmitted diseases can be controlled by TPS as TPS carries fewer pathogens, especially viruses (Hardy *et al.* 1995). The location of chitral is favorable with higher altitude, low temperature and longer photoperiod for production of true potato seed (TPS).

Highly significant differences were observed for days to flowering of potato genotypes. Patel *et al.* (2000) reported fifty percent flowering in four parental lines of TPS in the 2nd week of December, when the mean minimum and maximum values for temperature were 10°C and 20°C respectively and relatively humidity 25% and 75% respectively. Similarly Gopal, (1994) screened 344 accessions from solanum tuberosum, subspieces tuberosum for flowering under short day conditions but none of the genotypes flowered in this experiment. The potato genotypes showed significant variation for days to flower completion. Abeyunge (1992) reported seasonal differences for flowering and days to flower completion for different potato lines in his study.

Significant variations were observed among different genotypes for flowering duration in this study. Similar results have been reported by Gopal (1994) when he evaluated thirty potato accessions for flowering duration. A significant variation in percent pollen viability of different potato genotypes was observed. For the genotypes under study Gisela *et al.* (1990) evaluated twelve potato clones with low pollen fertility, under

different locations and pollen collection dates. He reported significant variation in pollen viability due to locations and date of collections. He reported 0-30% pollen viability in his study.

Flowering intensity and subsequent fruit set are important characteristics for the selection of TPS lines, as well as breeding potatoes. In most potato genotype, flowering is profuse under long day photoperiod and cool environment. The range of Flower plant^{-1} shows significant variation among different genotypes for no of flowers plant-1. Singh et al (1994) reported six to ten inflorescences of eight to ten flowers for an open pollinated true potato seed line, MST-1. Gopal (1994) reported that genetic as well as environmental factors inferred with the developmental process leading to flower production in different potato genotypes.

Our results showed significant level of variation between Desiree and cardinal for the no of berries plant^{-1} and the values ranged from 10.2 berries plant^{-1} for Desiree to 7.3 berries plant^{-1} for Cardinal. Singh *et al.* (1994) reported 28 to 58 berries plant^{-1} in OP TPS line MST-1under extended photoperiod (16 to 18 hrs).

No significant variations among the potato varieties were observed for berry diameter. The max was recorded for Cardinal of 2.3cm and the minimum diameter of 2.2 was recorded for Desiree. Almekinders and Wiersema (1985) reported that increase in the number of berries /inflorescence resulted in a decrease in the average berry size.

The potato genotype Desiree and cardinal did not vary significantly for average berry weight which is opposite to the study of Singh *et al.* (1994) who reported five to ten gram average berry weight for an OP TPS line under log day conditions.

Number of seeds berry^{-1} is an important trait that directly influence the production of OP and hybrid TPS. Significant variations were observed among potato genotypes for Number of seeds berry^{-1}. Upadhaya (1994) proposed that a

good parental line for TPS production should have more than 250 seed berry-1This was confirmed by genotype SH-103 that produced the highest no of seeds berry-1(355).

100 seed weight significant variation was observed between Desiree and cardinal for 100 seeds weight. A range of 54.5g to 55 was recorded in the present study which is contrast to the results of Almekinders and Wiersma (1985) who reported a range of 57.1 to 82.7 mg for 100 seed weight in three potato varieties.

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