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Screening and Evaluation of Initial Clonal Generations of Potato Hybrids for Yield and Yield Attributing Characters

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ABSTRACT

A field experiment was conducted during *Rabi* 2015-16 and 2016-17 at ICAR-Central Potato Research Station, Patna Bihar. To evaluate F_1 population and initial clonal generations *viz* F_1C_1, F_1C_2 and F_1C_3. The screening and selection of these generations were done for the characters like early bulking, tuber size, tuber shape, depth of eye, tuber colour and resistance to late blight of potato etc. A total of 12,360 True Potato Seeds of 17 successful crosses and 7,322 True Potato Seeds of 23 successful crosses were sown in the two years of experimentation and seedlings were transplanted, out of these 610 and 187 clones were selected during 2015-16 and 2016-17 respectively. Large number of potato cultures were planted for further evaluation in next generations. In F_1C_3 the cultures were planted along with more than six check varieties of potato. These cultures were evaluated and selected considering total tuber yield, shape, colour and disease reactions for further evaluation in PYT.

KEYWORDS

Screening, True potato seeds, Initial clonal generations, Cultures, Potato

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the important food crops cultivated all over India. It is a crop which has always been the poor man's friend, introduced to India from Europe in the beginning of seventeenth century (Singh C, 2001). It is an economical food, provide a source of low-cost energy to the human diet. This is most important crop after rice, wheat and maize (Singh *et.al*, 2015). It can be future crop for resolving global food security and poverty alleviation with increasing world population. It's easy cultivation and worldwide adoption has made it a valuable cash crop for millions of farmers in India and all over the world. India is the second largest producer of potato in the world after China (DAC, 2019). Its area, production and productivity have increased over last six decades by 8.5, 29.4 and 3.5 times, respectively (Kaur, 2017). However, with the rapidly increasing population the country faces multiple challenges in near future with regard to potato production and yield. Demand of potato will be approximately 125 m tones by 2050, from with the current production level in recent years approximately 51 m tones (ARDB, 2019). Potatoes are rich source of starch, vitamins especially C and B_1 and minerals (Fe, Zn, Ca, K etc.). The objective of the experiment was to develop cultivars with increased yield, improved quality of red skinned potato varieties. The cultivated potato has different ploidy levels and it is highly heterozygous tetraploid species 2n=4x=48 Chromosomes. The breeding of new varieties of potato is time taking process. As the first step, parents were selected as per need of the breeding program. Female parents were identified on the basis of desirable characters like earliness, early bulking, tuber colour, shape and depth of the eyes etc. Whereas male parents were selected for the characters like plant type, tuber colour and live pollen load in the anthers etc.

MATERIALS AND THE METHODS

A field experiment was carried out during two consecutive years i.e. 2015-16 and 2016-17 at ICAR- Central Potato Research Station Patna, Bihar. In this experiment initial clonal generations of Potato hybrids *viz*. F_1, F_1C_1, F_1C_2 and F_1C_3 were planted in the experimental field of crop improvement section. The soil texture sandy loam (Yadav *et al*., 2020). The nursery was sown during the last week of September and potato was planted during the last week of October to first week of November. The screening and selection of these generations were done in randomized block design for the character like early bulking, tuber size, tuber shape, depth of eye, tuber colour and resistance to late blight of potato etc. (Federer *et al*., 2012). These experiments were carried out with a total of 12,360 true potato seeds of 17 successful crosses during 2015-16 and 7,322 true potato seeds of 23 successful crosses during 2016-17, produced at ICAR- Central Potato Research Station, Kufri, Shimla by hand emasculation and pollination during *Kharif* season. The nursery of TPS was raised by soaking seeds in 1500 ppm GA_3 solution for 24 hours to enhance the germination (Chakraborty, 1991). After treatment, these seeds were drain out and mixed with fine FYM, and kept in the incubator at 24^{0}C temperature for 3-4 days or for one week to get better germination. Germinated seeds were sown on the raised nursery beds (15m x 1m x 60cm). Consequently 3090 and 4725 seedlings were planted during 2015-16 and 2016-17 in the main field (Table 1) respectively. These seedlings were transplanted at a distance of 10 cm on the ridge followed by light irrigation. Gap filling was done by identifying damaged, un-established seedlings followed by earthing up operation. About 921 and 561 F_1C_1 cultures were planted in single row

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of five tubers each in the 3m row length with 15 cm plant to plant distance. Whereas, 241 and 198 F_1C_2 cultures were planted in two rows of 3m length in three replications during 2015-16 and 2016-17 respectively. Thirty six and fifty two cultures of F_1C_3 along with six to seven controls (K. Khyati, K. Jyoti, K. Pushkar, K. Pukhraj, K. Lalima, K. Lalit & K. Sindhuri) were evaluated at 75 days in 3.6m^2 area in RBD in two replications during 2015-16 and 2016-17 respectively. These cultures were evaluated considering total tuber yield, shape, colour and disease reactions for further evaluation in preliminary yield trial. At the time of land preparation 25-30 tones of recommended farmyard manure, 1/2 N+P+K was applied in the soil. Chemical fertilizers were applied in the form of urea, DAP and MOP at the rate of 150: 80: 100:N:P:K. The tubers were planted in the rows, of 3m length at a distance of 15cm plant to plant and 60 cm row to row. The earthing up operation was done at 25-30 days after planting Weeding was done followed by application of rest amount of N for better tuber development. Data on germination count was recorded then diseased, off-type plants were rogue out before irrigation. All the plants of different clonal generations were harvested manually at 90 days after planting except F_1C_3 i.e. 75 days after planting (Fathi *et al.*, 2009). All the harvested tubers were graded, clone and replication wise their weight was recorded. The lots having more weight with desirable tuber colour, shape, size and depth of eyes were selected for further evaluation. All the observations were recorded and statistical analysis was done as per method suggested by Panse and Sukhatame, 1978. The difference between significant means were tested against C.D. at 5 percent of probability.

Fig. 1: Line sowing of potato clones

Fig 2: Planting of F_1C_1, F_1C_2 and F_1C_3 Clones

RESULTS AND DISCUSSION

Hybridization, TPS Production and Seedling Transplanting

A total of 12,360 and 7,322 True Potato Seeds of 17 and 23 successful crosses attempted at CPRS Kufri were sown in the nursery beds and consequently 3,090 and 4,725 seedlings were transplanted in the main field and 610 and 187 clones were selected on the basis of tuber colour, eyes depth, skin colour and shape of the tubers at 90 days harvest during 2015-16 and 2016-17 respectively. Besides, 303 and 280 clones were also selected from 18 and 14 populations of TPS project and included for further evaluation in F_1C_1 generation (Table 1). The selection of clones in F_1 is about 30% of the total planted clones. The selection process was also very specific and based on yield, tuber shape, size and color as per the consumer preference etc. The number of true potato seeds produced through emasculation and pollination were less (12360 and 7322) as compare to bulk method (28768 and 38176) due to selection, extraction of pollen and bud selective pollination and berry setting rate.

Table 1: Seeds sown, seedlings transplanted and clones selected in F_1 generation of potato hybrids during 2015-16 and 2016-17

Cross methodology	Number of seeds sown		Seedling transplanted		Clones selected	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Emasculation and pollination method	12360	7322	3090	4725	610	187
Bulk pollination	28768	38176	7653	6380	303	280
Total	41128	45498	10743	11105	913	467

Evaluation in F_1C_1 and F_1C_2 generations

Out of 921 and 561 cultures planted in single row of five tubers each only 227 and 76 cultures of 40 and 16 crosses were selected in F_1C_1 for further evaluation in F_1C_2 during 2015-16 and 2016-17 respectively. Out of 241 cultures planted during the season only 52 cultures of 24 crosses of F_1C_2 were selected during 2015-16 and Out of 198 cultures planted during 2016-17, only 75 cultures of 25 crosses of F_1C_2 were selected for further evaluation in F_1C_3 on the basis of tuber characters and L.B. resistance (Table 2). In the F_1C_1 and F_1C_2 generations the selection is about 13-24% and 21- 37% respectively, indicates the careful and specific process of selection. The selected clones were mostly red cultures as important objective of the research programme. These selected cultures were also high yielder as compare to the check varieties planted in the experiment.

Table 2: Selection of clones in Initial clonal generations during the two years

Clonal generation	No. of clones planted		No. of clones selected	
	2015-16	2016-17	2015-16	2016-17
F_1C_1	921	561	227	76
F_1C_2	241	198	52	75
F_1C_3	36	52	14	13

Table 3: Yield performance of selected hybrids in IET (F_1C_3) at 75 days harvest

Cultures	Germination % at 30 DAP 2015-16	Yield (t/ha)	Cultures	Germination % at 30 DAP 2016-17	Yield (t/ha)
PS/12-4	100.00	49.25	13KP-4	59	21.36
PS/12-5	95.00	48.46	13KP-4	48	23.05
PS/12-6	88.34	47.70	13KP-8	57	20.44
PS/12-7	95.00	49.57	13KP-15	53	21.36
PS/12-8	95.00	46.69	13KP-25	54	20.15
PS/12-16	93.34	46.74	13KP-49	57	25.02
PS/12-17	88.34	46.24	13KP-70	58	23.87
PS/12-19	88.34	47.21	13KP-73(B)	51	21.92
PS/12-22	58.33	46.14	PT/12-24	52	26.83
PS/12-37	66.67	43.64	PT/12-04	46	23.05
PS/12-38	91.67	45.61	PT/12-26	51	23.93
PS/12-39	95.00	47.40	PT/12-33	51	26.04
PS/12-40	91.67	44.98	PT/14-01	55	26.45
PS/12-41	90.00	46.63	K. Lalit	51	21.14
K.Khyati	95.00	44.79	K. Lalima	59	19.08
K.Jyoti	95.00	42.08	K. Sinduri	56	19.62
K.Pushkar	81.67	41.77	K. Ashoka	56	22.55
K.Pukhraj	93.34	40.23	K. Pukhraj	56	24.35
K.Lalima	86.67	38.88	K. Khyati	58	22.96
K.Lalit	98.34	38.59			
K.Sindhuri	93.33	35.93			
CD (0.05)	14.08	4.46	CD (0.05)	8.08	3.32
CV (%)	8.19	7.62	CV (%)	4.19	6.69

Evaluation in F_1C_3 generation

Thirty six cultures along with seven controls (K. Khyati, K. Jyoti, K. Pushkar, K. Pukhraj, K. Lalima, K. Lalit and K. Sindhuri) were evaluated at 75 days in 3.6m^2 area in RBD in two replications. Out of them fourteen cultures were selected during 2015-16 whereas, Fifty two cultures along with six controls (K. Khyati, K. Ashoka, K. Pukhraj, K. Lalima, K. Lalit & K. Sindhuri) were evaluated at 75 days in 7.2m^2 area in RBD in two replications during 2016-17. Out of them thirteen cultures were selected considering total tuber yield, shape, colour and disease reactions (Gopal *et al.*, 1994 and Luthra *et al.*, 2001 & 2005). The selection in F_1C_3 was very important, as the selected clones were planted in the preliminary yield trial. Most of the clones were high yielder as compare to the check varieties planted in the trial. The planted check varieties were red and white. The tuber shape, size and depth of eye were also taken in to consideration along with late blight resistance and performance of the clones.

Fig 3: Tuber colour diversity in F_1

Fig 4: Variation in tuber shape and colour in F_1C_3

The range of germination was 81.67% (K. Pushkar) to 100% (PS/12-4) and the range of yield was 35.93t/ha (K. Sindhuri) to 49.57t/sa (PS/12-7) whereas, it was 48% (13KP-4) to 59% (K. Lalima) for germination % and for yield it was 19.80 t/ha (K. Lalima) to 26.45 t/ha (PT/14-01). The selected cultures were significantly superior over the checks planted during the year and selected for further evaluation in Preliminary Yield Trial. (Table 3)

CONCLUSION

In breeding of vegetable crops, the most important aim is to improve yield as compared to promising released varieties, (controls), including other important traits like resistance to insect-pest and diseases. In this study initial clonal generations were produced from TPS and were screened on the basis of agro-morphological characters and yield of genotypes under irrigated condition. It has been well established that selection for yield *per se* not be effective as yield is a function of various plant characters. Evaluation of yield contributing characters offers a systematic way of carrying out selection where such positive relationships can be easily worked out. However, the morphological traits like tuber colour, tuber eye depth, tuber shape are also important for assessment of a potato clones that play important role in selection and breeding of superior potato hybrids as per consumer preference.

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