PERFORMANCE OF POTATO GENOTYPES IN DIFFERENT MOISTURE CONDITIONS OF REGIONAL AGRICULTURE RESEARCH STATION AT PARWANIPUR, BARA, NEPAL

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ABSTRACT

Forty-three advanced potato clones were assessed at RARS Parwanipur Bara for their performance in three different moisture conditions; rain-fed (T1), mulching (T2) and irrigated (T3) during the years 2008/09 and 2009/10. The experiment was laid out in two factor-factorial designs considering moisture treatments as factor A and potato clones as B and years considered as the replications. All intercultural operations were followed as per the recommendations. Clone CIP 388764.26 was found highly susceptible and CIP 393280.64, MS 35.9, Des x LBr 40-10, BSU PO3 and Des x LBr 40-6 highly resistant to late blight disease in rainfed treatment, whereas in mulching, CIP 392242.25 was highly susceptible and LBr-40, Ca x LBr 40-6 and CIP 393280.64 were resistant. Likewise in irrigated treatment, Des x LBr 40.6 was highly susceptible and CIP 387115.8LB, CIP 389746.2 and Ca x LBr 40.6 were resistant. Average plant vigor was found lowest (7) in rainfed conditions compared to both of other treatments, but no difference was observed between mulching and irrigated treatments. There was no treatment effect on average number of main stems per plant; however irrigated treatment had higher number of main stems compared to others. Overall number of marketable tubers was counted more in irrigated treatment followed by mulching and rainfed, respectively, but, no differences in percentage marketable yield observed. In rainfed conditions, CIP 394004.161, CIP 396001.47 and Desiree produced the highest marketable tuber percentages, whereas in mulching, Kufri Giriraj, CIP 387115.8LB and CIP 392256.48 and in irrigated treatment, CIP 395192.1 were the highest marketable sized tuber yielder. CIP 388676.1 in rainfed, Kufri Sindhuri in mulching and irrigated treatment produced the highest number of marketable size tubers. Highest number and percentage of non-marketable yields were produced in irrigated conditions followed by mulching. The differences of 2.9 tons per hectare was observed between irrigated and rainfed treatments, whereas only the difference of 1.4 tons/ha was observed between irrigated and mulching treatments among the clones and moisture conditions tested. Overall performance of the clones CIP 395192.1, CIP 393663.8, CIP 386612.5, CIP 387115.8LB, CIP 397077.16, CIP 393077.159, CIP 394004.161, CIP 395192.1; Ca x LBr 40-7, CIP 396011.47 and CIP 388676.1 was better among all the clones tested in all the three moisture conditions at Parwanipur conditions.

INTRODUCTION

Potato is well adapted in different agro-ecologies and different soil regimes of Nepal, but when there are even slight deviations in the soil moistures, it can be adversely affected than other crops, which is mainly due to the shallow root systems and herbaceous nature of this crop. Normal season potato crop mostly suffers from heat and moisture stresses of during summer shortly after the emergence throughout the crop season and in the plains, crop suffers heat stresses at the early stage of the emergence and drought at later stage. Potatoes grown in rice-based cropping system in the valleys and plains, as a succeeding crop to the rice, utilizes residual moisture from the fields in early stage for the emergence, but as the plants reach to the tuberisation stage, the scarcity of irrigation and unavailability of soil moisture hampers the crop seriously. Some of the major potato growing areas of the country are rain-shadow where crop suffers from moisture stress every year and farmers do not obtain expected yield from this crop (NPRP, 2010).

Potato plant is herbaceous in nature and tuber consists of 80% water. Due to this reason, all the developmental stages of this crop plant remains susceptible to moisture stress, which makes plant highly sensitive to the stress which brings many physiological and bio-chemical changes in the plants and tubers as well (Bowen, 2003; Bansal and Nagarjan, 1987). Therefore, selecting suitable varieties have been remained always an essential task

in any of the successful potato programs in any of the potato growing countries of the world. In Nepal, systematic research of potato variety selection was started since the establishment of Nepal Agricultural Research Council (1991AD). Several attempts on finding high yielding and disease resistant varieties has resulted recommendations of several potato varieties for commercial cultivation in different agro-ecologies. But, studies focusing on finding varieties suitable to cope moisture stress and has not yet received due attention in Nepal. Variety NPI-106 has shown the tolerance against the moisture stress in the hills of Nepal (NPDP, 1988). Some of the mulching trials conducted in the past have demonstrated very positive effect on moisture retention and producing satisfactory tuber yields also. International Potato Cetner (CIP) contains the moisture stress tolerant genotypes in its gene bank, but the introduction of such germplasm may not suit Nepalese envrionment. Therefore, a study was undertaken to identify the potato genotypes suitable in rainfed, mulched and irrigated conditions, which is vastly prevailing in the country.

MATERIALS AND METHODS

Field experiment was conducted at Regional Agricultural Research Station, Parwanipur, Bara in clay type of soil. Total of 42 clones were tested and compared with variety Desiree. The experiment was laid out in 2 factor factorial (variety x moisture treatments) RCB design with 12 tubers per row. Well-sprouted tubers of 20 to 50 gm size were planted by hand and made the ridge with spade. The treatments applied were completely rain-fed, mulching and irrigated conditions. Rice straw was used as the mulching material. All other cultural practices were followed as per the recommendations both the years.

First irrigation was provided soon after the planting in all the treatments to help tuber emergence, thereafter the irrigation was completely stopped in rain-fed and mulching treatments, but the irrigated plots were irrigated frequently as per the requirement of the crop. Fertilizer was applied at the rate of 100:100:60 kg NPK and 20 tons FYM per hectare. Maximum, minimum temperature and rainfall data from the crop season were recorded.

The plant characters including plant emergence (at 30 days after planting), plant height (cm), plant uniformity (1-10 scale), late blight disease severity (1 to 9 scale), plant vigor (1-10 scale), number of main stems per plant and tuber yield and its attributes (number of plants harvested, number and weight fraction of the tubers in marketable (medium and over sized tubers) and non-marketable (under size) grades and tuber yield tons per hectare). The observed data were analyzed by using Statistical Software Gen-Stat 532-2 programme.

RESULTS AND DISCUSSION

Climatic data

The climate data of the research station from 2010/11 to 2011/12 during the crop season is presented in Table 1. During the cropping season, maximum temperature was recorded in March (30.4 °C) and minimum (19.3 °C) in January. Average maximum temperature during the cropping period remained 25.7 °C. Minimum temperature was recorded highest (16.3 °C) in November, whereas the lowest (8.5 °C) in January. Average minimum temperature during the crop period remained 11.9 °C. There was no any rainfall recorded in November and December months. Though this is not the crop growing period in terai, the highest precipitation (30.5 mm) was occurred in March.

Table 1: Climate data in the crop season of the study years (2010/11 and 2011/12)

Month	Max °C	Min °C	Rainfall (mm)
November	28.7	16.1	0.0
December	25.1	9.4	0.0
January	19.3	8.5	3.1
February	25.3	11.0	21.5
March	30.4	14.7	30.5
Mean	**25.7**	**11.9**	**11.0**

Effect of moisture conditions on vegetative characters

The effect of moisture conditions on plant characters of different potato genotypes are presented in Table 2. The clonal variation was observed distinct in plant emergence, but treatment effect was not seen which could be due to the residual moisture in the plots where the potatoes were planted after the rice crop or due to the first irrigation provided in all the plots immediately after planting. Majority of the clones showed excellent plant uniformity and ground cover in all the moisture treatments. It could be mainly due to the effect of the residual moisture in the fields at the emergence stage and frequent rainfall at later stage. In rainfed conditions, CIP 393077.159 and Des x 27/40-8 had the highest plant vigour (10) in 1 to 10 scales. The plant vigour of the crops was observed mainly governed by moisture therefore, majority of the clones showed better growth in mulching and regular irrigation treatments, but no differences was observed between these two treatments. Plants were poorer in rainfed conditions compared to other two treatments.

The response of potato genotypes to late blight disease differed with the treatments applied. However, clones BSU PO3, CIP 389746.2 and LBr-40 were found highly resistant and Kufri Giriraj, Khumal Laxmi and CIP 391598.75 highly susceptible to this disease in rainfed plots, whereas in mulching, LBr-40 was found highly resistant (2) and CIP 391598.75 highly susceptible (8). LBr-40 was observed highly resistant (2) to late blight in irrigated plots, whereas, Baronesa, Andinita, Kufri Badshah, CIP 391004.15 and CIP 388764.26 were highly susceptible scoring up to 7. The occurrence of late blight was comparatively lower in rain-fed plots compared to the mulching and irrigated treatments. The irrigation and mulching treatments in potato crop might be contributing to create the favourable environment of spreading the pathogens.

In irrigated condition, the highest number of stems per plant (5.2) was counted in LBr-44 followed by LBr-40 (5.0) and CIP 392244.3 (4.6), respectively.

Table 2: Response of potato clones in different moisture conditions

	Emergence (%)			Plant vigor (1 -10)			Late blight (1-9)			Stems/plant (#)		
Varieties	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
BR 63.65	100	100	100	7	9	9	3	6	7	2.5	2.2	2.4
Baronesa	94	100	95	7	10	7	4	3	5	3.2	3.6	3.1
393280.64	100	95	100	6	10	9	2	2	3	2.3	1.9	2.4
MS 35.9	100	95	100	6	9	8	2	6	4	2.1	2.0	2.0
Des x LBr		100	96									
40-10	85			7	10	7	2	3	5	2.3	2.3	2.1
378711.7	100	100	95	7	9	10	3	5	7	1.9	2.8	2.6
393663.8	100	100	80	6	10	10	3	6	3	2.2	2.7	3.1
Andinita	100	100	90	6	9	8	3	5	7	2.5	2.8	3.9
K.Giriraj	90	100	100	6	8	7	5	8	7	1.7	2.8	2.5
NPI-106	100	96	100	5	9	8	5	6	7	3.6	2.4	2.9
K.Laxmi	90	82	100	6	9	7	6	7	5	2.2	2.6	2.4
LBR 44	100	100	100	7	10	8	2	4	3	2.8	3.4	4.3
386612.5	95	100	100	6	10	8	3	5	4	3.3	2.3	2.7
BSU PO3	100	100	95	6	8	9	2	4	3	2.3	1.6	2.8
PRP		100	95									
35861.13	100			6	10	10	3	4	4	2	2.5	2.2
389660.9	94	96	100	7	9	9	3	6	5	3.8	2.8	2.8
L 235.4	100	100	100	7	10	9	3	6	4	2.2	2.1	2.2
Des x LBr		100	90									
40-6	100			6	9	8	2	7	8	2.5	1.7	1.8
388576.1D	100	100	91	6	9	9	4	7	5	1.8	2.3	3.2
392244.3	95	96	95	6	10	9	3	8	4	1.9	2.8	3.0
K.Ashoka	89	92	92	6	8	8	4	9	4	1.7	2.2	2.1
K.Badsah	100	84	96	9	10	9	2	4	5	2.5	2.6	3.4
387115.8LB	100	100	100	9	9	10	4	4	2	2	3.4	3.7
391004.18	100	95	95	9	9	10	3	6	5	2.9	2.5	3.7
397077.16	100	95	100	10	10	9	3	4	4	2.3	3.6	2.6
393077.159	95	86	90	9	9	9	4	4	2	3.5	2.6	2.6
392243.17	95	100	100	9	10	8	3	6	6	2	2.4	1.9
388764.26LB	100	95	95	9	10	9	6	7	5	2.1	1.9	2.3
Dx27/40-8	100	95	95	10	10	8	3	5	4	2.6	1.8	1.8

394004.161	90	100	95	9	10	10	4	6	6	3	2.7	2.7
395192.1	95	100	100	9	9	10	4	6	6	3.6	3.3	3.4
Desiree	90	100	100	9	9	10	4	5	5	2.3	2.9	2.7
394034.65	100	95	95	8	9	9	3	4	3	1.7	1.9	2.7
Cax27/40-7	100	100	92	9	9	8	3	4	5	3.1	2.9	2.2
391598.75	95	100	100	8	9	9	5	8	7	2.9	1.8	1.9
396011.47	95	95	95	9	9	10	4	8	4	3.2	3.3	3.1
392242.25	100	96	90	8	10	9	5	9	7	3.5	2.9	3.2
388676.1	100	95	90	9	9	9	5	8	4	3.8	2.6	2.9
392256.48	100	100	100	8	9	9	4	4	3	2.2	2.5	2.0
389746.2	100	100	95	9	10	9	3	3	2	3.1	3.6	3.4
Ca x LBr 40-6	100	87	85	7	8	9	3	2	2	2.2	2.2	1.8
K.Sindhuri	100	100	100	8	9	9	3	3	4	2.9	2.7	3.1
LBR 40	100	100	100	8	8	8	2	2	5	3.0	4.1	3.5
Mean	**97**	**97**	**97**	**7**	**9**	**9**	**3**	**5**	**5**	**2.6**	**2.6**	**2.7**
Maximum	**100**	**100**	**100**	**10**	**10**	**10**	**6**	**9**	**8**	**3.8**	**4.1**	**4.3**
Minimum	**85**	**82**	**80**	**5**	**8**	**7**	**2**	**2**	**2**	**1.7**	**1.6**	**1.8**

Treatments: T1: rain-fed ; T2: mulching ; T3: irrigated

Effect of moisture conditions on tuber yield

Though the treatment effect was observed was highly contributing in the clones tested in the trial, overall percentage of marketable tubers did not differ between the rainfed and mulching treatments. Percentage marketable tubers were lower in irrigated treatments, which could be due to the delayed maturity period due to high vegetative growth and more production of undersize tubers (Table 3).

Table 3: Response of potato clones in moisture conditions

	Marketable (%)			Marketable (#)			Non-marketable (%)			Non-marketable (#)			Yield t/ha		
Clones	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
BR 63.65	91	96	90	49	43	65	9	4	11	33	17	27	21.3	24.5	28.8
Baronesa	90	95	85	37	45	37	11	6	15	33	18	29	17.3	23.3	18.8
393280.64	91	92	92	40	47	49	8	7	8	23	42	33	19.3	28.1	27.5
MS 35.9	87	92	93	41	55	50	12	8	8	28	44	28	14.7	22.9	26.2
Des x LBr 40-10	91	96	95	33	47	41	10	4	5	28	24	14	19.7	15.5	31.7
378711.7	87	96	92	33	39	55	13	4	9	18	19	14	21.6	29.0	27.9
393663.8	94	92	91	42	54	41	7	8	9	16	24	26	27.5	28.2	30.4
Andinita	93	93	82	27	36	28	8	7	19	14	20	41	11.8	18.8	17.5
K.Giriraj	95	97	88	24	35	28	4	4	13	7	9	17	9.1	12.9	14.8
NPI-106	91	94	88	49	32	58	10	6	11	25	15	35	19.1	14.5	21.5
K.Laxmi	93	92	92	41	40	49	8	8	8	18	21	21	15.7	16.3	17.3
LBR 44	88	81	80	26	37	30	13	19	21	19	35	33	7.7	9.4	15.3
386612.5	95	96	94	40	46	51	6	4	6	15	20	16	23.8	24.0	32.3
BSU PO3	94	94	77	34	37	26	7	5	23	11	16	42	18.3	21.8	21.3
PRP35861.13	95	93	89	26	30	34	5	6	11	5	15	21	15.3	17.3	24.9
389660.9	95	94	92	38	41	41	6	58	9	18	18	16	21.2	20.2	33.3
L 235.4	96	87	87	29	28	46	4	13	13	15	27	37	18.3	17.4	19.4
Des x LBr 40-6	96	94	80	39	35	25	4	6	20	10	15	22	19.3	18.6	18.3
388576.1D	93	96	92	29	34	47	8	5	8	17	14	21	17.3	17.9	23.4
392244.3	93	93	88	27	42	34	8	8	12	17	28	26	20.2	19.3	19.3
K.Ashoka	96	82	79	23	25	31	5	18	21	6	11	32	14.1	11.1	5.8
K.Badsah	93	95	82	38	42	46	7	6	18	19	22	39	17.2	21.2	22.2
387115.8LB	93	97	93	37	39	40	7	3	8	16	14	24	22.2	27.0	23.0
391004.18	93	94	85	35	53	48	6	6	15	14	23	37	18.9	27.7	16.7

397077.16	94	90	92	47	33	31	6	11	9	23	28	18	24.6	19.7	26.0
393077.159	95	96	94	45	37	37	4	4	6	20	16	13	22.7	25.6	28.3
392243.17	94	87	85	45	53	37	6	13	15	21	35	33	23.2	26.1	18.8
388764.26 LB	91	92	85	41	45	52	9	8	15	26	23	37	17.7	30.1	16.0
Dx27/40-8	90	88	77	39	37	36	10	13	23	23	26	48	14.3	17.3	21.3
394004.161	97	96	92	37	36	47	3	4	8	8	10	26	23.3	24.3	25.4
395192.1	94	96	96	48	46	43	6	5	4	20	16	13	31.5	29.7	25.9
Desiree	97	91	91	42	44	46	4	9	9	15	27	19	20.0	14.5	25.5
394034.65	92	93	93	25	27	54	8	7	7	19	27	26	18.1	14.7	19.3
Cax27/40-7	92	91	92	40	43	39	8	10	8	18	28	12	22.3	17.0	15.3
391598.75	90	90	88	43	45	36	9	10	11	35	29	20	24.4	28.5	14.3
396011.47	97	90	89	42	49	48	3	9	11	13	28	31	26.3	34.8	25.6
392242.25	89	93	93	35	37	52	10	7	7	20	16	18	12.2	16.5	21.3
388676.1	94	96	93	51	47	45	6	4	7	18	25	20	28.6	24.3	35.7
392256.48	95	97	92	35	45	39	4	4	9	13	18	14	21.2	22.7	21.3
389746.2	94	87	90	42	37	33	6	13	10	17	35	22	21.5	14.8	24.3
Ca x LBr 40-6	90	87	95	39	34	49	11	13	6	33	36	18	9.6	13.4	27.9
K.Sindhuri	76	90	89	38	59	69	24	11	11	42	51	75	13.9	25.8	19.5
LBR 40	96	86	92	34	34	33	4	14	8	17	16	14	32.4	18.3	15.3
Mean	**92**	**92**	**88**	**37**	**40**	**42**	**7**	**9**	**11**	**19**	**23**	**26**	**19.5**	**21.0**	**22.4**
Maximum	**97**	**97**	**96**	**51**	**59**	**69**	**24**	**58**	**23**	**42**	**51**	**75**	**32.4**	**34.8**	**35.7**
Minimum	**76**	**81**	**77**	**23**	**25**	**25**	**3**	**3**	**4**	**5**	**9**	**12**	**7.7**	**9.8**	**5.8**

Treatments: T1: rain-fed; T2: mulching; T3: irrigated

In rainfed treatment, CIP 394004.161, CIP 396011.47 and Desiree produced the highest percentage of marketable tubers (97%) and the lowest by Kufri Sindhuri (76%), whereas, in mulching treatment, CIP 387115.8LB, Kufri Giriraj and CIP 392256.48 produced the highest percentage (97%) of marketable tubers. Clone CIP 395192.1 performed better in irrigated condition; therefore, the highest percentage (96) of marketable tubers was obtained in this treatment. CIP 388676.1 produced the highest number (51) of marketable tubers per plot followed by NPI 106 (49) in rainfed conditions. In mulching and irrigated treatment both, variety Kufri Sindhuri produced the highest number (59) and lowest by Kufri Ashoka (25). In irrigated conditions, number of marketable tubers increased to 69 in Kufri Sindhuri followed by BR 63-65 (65). CIP 389660.9 (58) and BSU PO3 and Kufri Sindhuri had the highest number of non-marketable tubers in all the treatments.

In rainfed conditions, LBr-40 produced the highest tuber yield (32.4 t/ha) followed by CIP 388676.1 (28.6 t/ha) and CIP 393663.8 (27.5 t/ha), respectively whereas the lowest yield (7.7 t/ha) was recorded in LBr-44. In mulching treatment, CIP clones 396011.47, C388764.26LB, 395192.1 and 378711.7 yielded 34.8, 30.1, 29.7 and 29.0 t/ha, respectively. CIP 388676.1 gave highest yield (35.7 t/ha) and Kufri Ashoka as the lowest yielding (5.8 t/ha) genotype in irrigated conditions. Genotypic differences in response to water supply were observed very high.

The performance of the clones was found more dependent on rainfall of that season (Table 3) since both of the years rainfall at tuberisation stage was enough to support the crops to give good yields. In rainfed conditions, LBr 40 was highest yielder (32.4 t/ha) followed by CIP 395192.1 and CIP 388676.1, whereas in mulching and irrigated conditions, CIP 396011.47 and CIP 388676.1 were the highest yielders (Table 3). Among 42 clones tested, 18 clones performed better in rainfed conditions, 34 clones in mulching and 11 clones in irrigated in producing higher tuber yields. Treatment effect was not apparent in the performance of clones BR 63/65, CIP 378711.7, CIP 393663.8, Khumal Laxmi, CIP 388612.5, CIP 389660.9, Des x LBr 40-6, CIP 392244.3CIP 387711.8LB, CIP 393077.159, CIP 394004.161, CIP 396011.47, CIP 388676.1, CIP 395192.1 and CIP 389746.2 among all the 43 tested clones in the trial.

CONCLUSION

The genotypes used in this study showed the huge variation in their plant and yield characters in different moisture conditions. The genetic makeup of the cultivars might have the effect causing predominantly the yield variation in different moisture conditions. Though irrigation is the major strategy for maintaining adequate soil moisture, results showed that mulching also can substitute the irrigation where the facilities for irrigation are

lacking. Rainfed conditions was not conducive to late blight disease, therefore majority of the clones which were susceptible in mulching and irrigated treatments were less affected in this treatment by the disease, however, susceptibility of some clones remained same in all of the three moisture conditions.

REFERENCES

Bansal, KC and S. Nagarjan, 1987. Reduction of leaf growth by water stress and its recovery in relation to transpiration and stomata conductance in some potato genotypes, potato Research, 30(1987)#4

Bowen, WT, 2003. Water productivity and potato cultivation, CAB International, Water productivity in agriculture: Limits and Opportunities for improvement (Eds. JW Kijne, R, Barker and D. Molden)

NPDP, 1988. Annual Report, National Potato Development Programme, Khumaltar, Lalitpur

NPRP, 2010. Annual Report, National Potato Research Programme, Khumaltar, Lalitpur