

IPY-8 and Khumal Laxmi: Newly Released Potato Varieties

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ABSTRACT

Several on-station and on-farm results demonstrated that CIP clones 388572.4k and 388572.1k are high yielder and moderately resistant to late blight and suitable for commercial cultivation in different agro-ecological domains of Nepal. Both of these cultivars are economically profitable in comparison to previously released potato varieties. In the trials, both of the clones were observed medium maturing type taking 100 to 120 days to harvest, which makes the clones fit in existing cropping systems. Main stems were counted average of 3 to 5 per plant and had medium height. Average tuber yield from CIP 388572.4k was 25 to 27 t/ha and that from CIP 388572.1 was 24 to 28 t/ha i.e. 3 to 6 tons higher than previously released varieties. Tubers had medium dormancy with low dry matter content (average of 17.1%) and medium (1.07) specific gravity. Farmers' preferences demonstrated the potentiality of good fresh market. Based on all of these superior characteristics, clone 388572.4k was released for commercial cultivation as variety "IPY-8" suitable for terai and clone 388572.1k as "Khumal Laxmi" from terai to high-hills on the year 2008.

Keywords: Clones, IPY-8, Khumal Laxmi, on-farm, on-station, varieties

INTRODUCTION

Demands of high yielding potato (*Solanum tuberosum* L.) varieties for disease and pest resistance have been increasing day by day in Nepal. Fulfillment of this demand is only possible through the development of new varieties for cultivation and recommendation of improved package of practices for commercial cultivation in the country (Khatri and Shrestha, 1999). Variety development at present in Nepal is done through own conventional breeding programme or through the introduction of exotic clones mainly from International Potato Center (CIP) Lima Peru. Own national breeding programme is still in its initial stage; therefore, National Potato Research Programme (NPRP) evaluates and compares the performance and potentiality of introduced clones with established varieties under glasshouse and on-station conditions first. High yielding and disease resistant clones are later assessed under on-farm conditions throughout the country. After the evaluation for couple of years, only highly preferred clones are proposed to release as the varieties for respective agro-ecological zones.

To systematize the varietal research, NPRP has developed a varietal evaluation scheme since long time and follows the steps through preliminary observation nurseries (PONs), initial evaluation trials (IETs), co-coordinated varietal trials (CVTs) and coordinated farmers field Trials (CFFT) and farmer's acceptance test (FAT). Each of these steps takes at least 2 years for each clone. After 10 to 12 years' on-station and on-farm efforts of selection and testing in different agro-ecological domains, highly suitable clones are recommended for releasing. In all of these steps, development of high yielding potato varieties with resistance to major diseases, like late blight (*Phytophthora infestans*) and wart (*Synchytrium endobioticum*) are the priority areas of NPRP Variety Research Unit (NPRP, 2007). Hattiban Research Farm Khumaltar (1350 masl) along with all of the research stations under NARC representing different domains are the major collaborators of NPRP for on-station experiments. Potato growers from out-reach research (OR) sites are

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considered as collaborator farmers participating in variety development scheme (Khatri *et al.*, 1999). This has resulted to release Kufri Sindhuri, Kufri Jyoti, Desiree, Khumal Rato-2, Khumal Seto-1 and Janak Dev so far for different agro-ecological domains of the country (NPRP, 2007). But naturally, after the use for some years, these varieties start losing their resistance against diseases and reduction in tuber yield starts, hence; needs to be replaced by superior clones regularly.

A series of on-station and on-farm studies carried out during the years 1990/91 to 2005/06 throughout the country demonstrated both of the CIP clones 388572.4k and 388572.1k superior to the check varieties (Khatri *et al.*, 2005) hence released as the varieties for commercial cultivation for terai and hills respectively. The materials and methods used in experiments are presented in material and methods and morphological and yield data gathered in the studies are presented in the results.

MATERIALS AND METHODS

For both of the clones, PONs, IETs, CVTs, CFFT and farmers' acceptance tests (FATs) were the evaluation steps followed as per the variety evaluation scheme. Each clone was evaluated for at least two years in each experimental site. All the cultural practices were followed as per the recommendations of NPRP (Dhital and Khatri, 2008). The vegetative and yield parameters were recorded as per the requirement of experiment throughout the study period following protocol developed by Khatri *et al.*, (1999).

IPY-8 (Clone CIP 388572.4k)

On-station studies

During 1990/91 to 1996/97 along with several other new clones the performance of this clone was evaluated and compared with check varieties Kufri Jyoti, Kufri Sindhuri, Desiree, Khumal Seto-1 and farmers' local at NPRP Khumaltar, Horticulture Farm Daman, Regional Agriculture Research Station (RARS) Parwanipur Bara, RARS Tarahara, RARS Nepalgunj and Hill Crop Research Programme (HCRP) Kabre, Dolakha. Promising clones were selected and promoted to on-farm studies.

On-farm studies

Based on the performance observed from series of on-station trials further verification of this clone was done at farmers' fields as CFFT and FAT in the command areas of RARS Tarahara and Nepalgunj, representative sites from wet-terai and dry-terai, respectively during the years 1999/2000 to 2004/2005. Late blight disease response was observed all the years in trials and additionally at RARS Parwanipur during the year of 2005/06. Plant type, LB resistance, tuber yield, tuber appearance and taste results were the major parameters of variety selection along with the preference ranking of farmers recorded right at harvest of the trial as good (G), fair (F) and very good (VG).

Khumal Laxmi (Clone CIP 388572.1k)

On-station studies

Preliminary observations on performance for this clone were taken at NPRP Khumaltar, Nucleus Seed Potato Centre Nigaley and RARS Parwanipur during the years 1991/92 to 1994/95. IETs were carried out at RARS Parwanipur and NPRP Khumaltar, as the representative sites of terai and hill, respectively. CVTs were carried out at RARS Nepalgunj, RARS Tarahara, HCRP Kavre Dolkha, RARS Lumle and ARS Pakhribas in different years. Based on the results obtained from on-station experiments, this clone was promoted to on-farm studies.

On-farm studies

The performance of this clone under farmers' field conditions, number of trials were conducted at OR site Mainapokhar of RARS Nepalgunj, Mahuli site of RARS Tarahara, Bhakkimle and Hemja site of RARS Lumle, Sanagaun and Mulpani sites of NPRP Khumaltar and Basantapur site of ARS Pakhribas during the years 1989/99- 2006/07. In addition, this clone was further evaluated against late blight disease at NPRP Khumaltar and at RARS Parwanipur during the year 1993/94 and 1994/95. The tuber yield and farmers' preferences on evaluation clone were rated as in clone CIP 388572.4k.

RESULTS AND DISCUSSIONS

The major morphological features, varietal characteristics and reasons for recommendations of these two varieties are compiled and presented as the text below and yield results and farmers' rating on different parameters are in respective tables.

IPY-8 (CIP 388572.4k)

Plant characteristics

<i>Growth habit:</i>	Medium height, vigorous, spreading and open type
<i>Stems:</i>	Few, medium thick and green color, slightly hairy, straight and well developed wings
<i>Leaves:</i>	Stiff deposition, green rachis color, ovate lanceolate, close type, smooth surface and grey green foliage, glossiness, wavy leaf margin, few folioles and pointed tips in leaves
<i>Flowers:</i>	Few flowering in short day conditions, open-pollinated and fruiting occurs in the field, dropping flowers type with yellow anther
<i>Response to diseases:</i>	Field resistant to late blight and susceptible to wart disease
<i>Response to the pests:</i>	Not studied
<i>Response to climate:</i>	Not studied
<i>Stem density:</i>	3-4 stems/plant
<i>Maturity:</i>	Medium (100 to 120 days after planting) type
<i>Tubers:</i>	Medium sized with smooth skin surface, slightly developed eye-brows, red eye and creamy flesh
<i>Number of tuber/plant:</i>	10-12 tubers
<i>Sprouts:</i>	Bulbous sprout type, moderate violet color with many root tips
<i>Tuber shape:</i>	Round
<i>Tuber color:</i>	White
<i>Eye depth:</i>	Medium
<i>Dormancy period:</i>	Medium (6 to 8 weeks from harvest days)
<i>Average yield:</i>	25-27 t/ha

Special features

- Can be grown successfully in inner terai and terai domains
- Field resistant to late blight disease
- Yielding higher than previously released varieties (Kufri Jyoti, Kufri Sindhuri and Desiree)

Reason for recommendation

In the main winter season, this clone/variety has been superior in plant and yield parameters to Kufri Sindhuri, Desiree and Khumal Seto-1 and farmers' local in study areas. In on-station condition this clone gave average of 24.7 tons per hectare tuber yield, whereas check variety Kufri Sindhuri gave 18.9 t/ha and Desiree 11.7 t/ha and Khumal Seto-1 19.1 t/ha, respectively. Under on-farm conditions, average yields of IPY-8 was recorded 26.9 t/ha, whereas with varieties Kufri Sindhuri, Desiree, farmers' local, Khumal Seto-1 and Cardinal, average yields were obtained 20.8, 20.9, 16.6, 22.4 and 11.7 t/ha, respectively (Table 1, 2 and 3). Farmers' preference assessed for this clone showed that plants and taste of this clone was rated as very good compared to check varieties Kufri Sindhuri and Desiree (Table 3).

Recommended domain: Terai and inner terai of Nepal
Cropping season: Winter main season (November planting)
Moisture regime: Irrigated conditions
Growing seasons: Better in winter season
Cropping pattern: Rice-potato
Rice-potato-summer vegetables
Rice-potato-maize

Recommended fertilizer dose: 100:100:60 NPK kg + 20 tones compost/FYM per hectare
Economical rating: profitable

Yield and quality

In main crop-season trials conducted during 1993/94 to 1996/97 under on-station irrigated conditions from terai and inner Terai, yield data indicated that 388572.4k is generally a high yielder clone. If averaged between the years and locations, this clone gave 38.8% higher yields than check variety Kufri Sindhuri, and 80% higher than Desiree (Table 1). In all the locations where the experiments were undertaken, this variety was found superior to all of the check varieties, however, a considerable variation was observed between year to year and locations to locations in the yields. Yield data if averaged between the years 1993/94, 1994/95, 1995/96, 1997/98 and 1998/99, tested clone CIP 388572.4k yielded highest (26.1 t/ha) followed by Kufri Sindhuri (18.8 t/ha) and Desiree (14.5 t/ha) respectively (Table 1).

Table 1: On-station yield performance of clone 388572.4k compared with three commercial check varieties during main winter season in terai and HCRP Kabre

Cultivars	RARS Parwanipur		RARS Nepalgunj		RARS Tarahara		HCRP Kavre	Average (t/ha)
	1993/94	1994/95	1995/96	1996/97	1996/97	1996/97	1996/97	
388572.4k	43.0	20.7	38.1	23.8	17.5	21.8	17.5	26.1
K. Sindhuri (ch)	27.4	-	23.6	19.0	15.8	13.6	13.5	18.8
Desiree (ch)	-	9.8	26.8	13.4	11.3	11.5	13.9	14.5
Khumal Seto (ch)	-	19.1	-	-	-	-	-	19.1

As in on-station conditions, the clone 388572.4k performed better in tuber yields under on-farm conditions also (Table 2). Highest yields were obtained from tested clone 388572.4k (26.3 t/ha), followed by the check varieties Kufri Sindhuri (20.5 t/ha), Desiree (22.0 t/ha)

and farmers' local (15.8 t/ha). In all the years and in both of the domains clone 388572.4k was found superior to all of the three check varieties. The yield was 28.3% higher than Kufri Sindhuri, 19.5% higher than Desiree and 66.5% higher than farmers' local. Except in the year 2000/01 from RARS Tarahara site, all three check varieties were inferior to this clone in all the sites and years tested.

Table 2: On-farm yield performance of clone 388572.4k compared with commercial varieties as CFFT's at different OR sites from regional research stations

Cultivars	RARS Nepalgunj			RARS Tarahara					Avg. yield (t/ha)
	1999/00	2000/01	2004/05	1999/00	2000/01	2001/02	2004/05	2005/06	
388572.4	29.1	28.1	27.6	32.5	24.7	23.7	26.4	18.0	26.3
K. Sindhuri (ch)	21.6	21.9	22.4	23.3	24.4	16.2	22.5	12.0	20.5
Desiree (ch)	19.1	20.7	26.4	17.3	27.6	20.6	22.6	-	22.0
Farmers' local (ch)	18.9	-	-	11.8	16.8	-	-	-	15.8

Results on farmers' preference ranked as good (G), fair (F) and very good (VG) are presented in Table 3. The results showed that plant appearance and taste at harvest ranked VG with clone 388572.4k by the participating farmers from OR site of RARS Tarahara whereas variety Kufri Sindhuri was inferior in tuber assessed, whereas variety Desiree was preferred for its tuber appearance and taste.

At OR site of RARS Nepalgunj, yield of tested clone CIP 388572.4k and Desiree one of the check variety was highly preferred and ranked as very good by the participating farmers but all of other parameters were ranked good (G). If averaged over the sites and parameters assessed, the clone CIP 388572.4k and Desiree were categorized as good as and better than Kufri Sindhuri (Table 3).

Table 3: Farmers' preference on CIP 388572.4k compared with 2 commercial varieties

Cultivars	OR site of RARS Tarahara				OR sites of RARS Nepalgunj				Average
	Plant	Tuber	Yield	Taste	Plant	Tuber	Yield	Taste	
388572.4k	VG	G	G	VG	G	G	VG	G	GOOD
K. Sindhuri (ch)	G	F	G	G	G	G	G	G	GOOD
Desiree (ch)	G	VG	F	VG	G	G	VG	G	GOOD

Farmers' preference ranking: G= good, F= fair, VG= very good

CIP 388572.1k (Khumal Laxmi)

Plant characteristics

- Plant growth habit:* Tall, vigorous, erect, open with medium compactness
- Stems:* Medium thickness, 3 - 5 stems/plant, slightly hairy stem and some pigments on stem, wings are wavy, broad and prominent on stem,
- Leaves:* Ovate with medium developed lateral leaflets, open leaves with drooping disposition, rough surface and dark green foliage entire leaf margin and moderate number of folioles.
- Flowers:* Reddish pink petal flower, profused in number and berry set in long-day conditions, few flower in short day conditions
- Tubers:* Small to large size, round/red skin, smooth surface, creamy white flesh and floury texture, 10 to 15 tubers/plant, medium and well distributed eye depth.
- Sprouts:* Bulbous type of sprout, very intense blue-violet color with many root hairs.

Maturity: Medium (100-120 days) in terai and long (120-140 days after planting) in the hills
Stem density: 3 to 5 stems/plant
No. of tubers/plant: 10-15
Dormancy period: Medium (6 to 8 weeks after emergence)
Average yield: 24-28 t/ha
Response to diseases: Wart and late blight resistant, early blight tolerant
Response to the pests: Not studied
Response to abiotic factors: not studied
Response to climate: Not studied

Special feature

- Can be successfully grown from terai to high hills
- High yielder than all of the previously released varieties such as Kufri Jyoti, Desiree and Kufri Sindhuri
- Good yielder even in drought condition
- Economically profitable
- Red skinned tubers
- Highly preferred by the farmers

Reason for Recommendation

Clone CIP 388572.1k released as Khumal Laxmi has red skinned tuber which is highly preferred characters of potato consumers in Nepal. Eye-depth is medium which is another preferable character since deeper eyes have higher peel loss. Cooking quality, taste, aroma and flavor like characters are also preferable in this clone. Plants are resistant to wart and moderately resistant to late blight diseases. This is medium maturing variety and yields are higher than almost all of the check varieties. Cultivation is profitable and farmers' preference on the appearance of plant, tuber, taste and tuber yield is higher than check varieties Kufri Jyoti and Desiree.

Recommended domain: Wide adoptability (Terai to mid and high hills)
Moisture regime: Partially irrigated, good yield even in drought conditions,
Growing season and condition: Better for spring planting in hills and mid-hills and winter planting in terai
Cropping pattern: Mid-hills: rice-potato-maize
 High hills: Maize-potato
 Terai: Rice-potato-summer vegetables
 Rice-potato-maize

Recommended fertilizer dose: 100:100:60 kg NPK + 20 tones compost/FYM/ha
Economic analysis: Profitable
Tuber color:: Red skinned
Tuber shape: Round
Tuber size: Red
Eye depth: Medium
Farmers' preferences: High

On-station yield and quality

Tuber yield data from on-station trials carried out at NPRP Khumal, Nucleus Seed Potato Farm (NSPF) Nigaley, RARS Lumle and ARS Pakhribas during the years 1993/94-1995/96 showed that clone 388572.1k is very high yielder compared to check varieties Kufri Jyoti and Desiree. Average yields from all the experimentation years in the hills were 26.2 t/ha with CIP 388572.4k which was 86.6% higher than Kufri Jyoti and 90.6% higher than Desiree (data not shown). Tuber yields of Kufri Jyoti and Desiree were 14.2 t/ha and 13.9 t/ha, respectively (Table 4).

Table 4: On-station yield performance of clone 388572.1k compared to 3 check varieties in the hills of Nepal

Clone	NPRP Khumal		NSPF Nigaley	RARS Lumle	ARS Pakhribas	Average (t/ha)
	1993/94	1994/95	1993/94	1995/96	1995/96	
CIP 388572.1	28.2	24.0	30.0	27.2	23.0	26.2
Kufri Jyoti (ch)	15.5	-	20.0	10.6	10.7	14.2
Desiree (ch)	-	11.7	-	14.4	15.6	13.9

Same set of on-station varietal trials were conducted in terai during 1994/95 to 1997/98 and results showed that the clone CIP 388572.1k performed better in tuber yields at HCRP Kabre Dolakha also (Table 5). Average yields of 30.4 t/ha was obtained from tested clone whereas in Desiree and Kufri Sindhuri, 11.9 t/ha and 16.2 t/ha, respectively. Site to site variation in tuber yield was very high in tested clone than in the check varieties. The yield in tested clone was 155.4% higher than variety Desiree and 87.6% higher than Kufri Sindhuri.

Table 5: On-station yield performance of clone CIP 388572.1k compared to 2 check varieties in winter season planting

Clone	RARS Parwanipur Bara		RARS Tarahara Sunsari		RARS Nepalgunj	HCRP Kabhre Dolakha	Average (t/ha)
	1994/95	1995/96	1996/97	1997/98	1997/98	1997/98	
	CIP 388572.1k	26.9	41.8	39.9	29.3	23.5	
Desiree (ch)	10.1	11.5	11.5	13.4	11.5	13.9	11.9
K. Sindhuri (ch)	20.4	13.1	13.6	20.3	13.6	16.3	16.2

On-farm yield and quality

On-farm experiments on promising clones were undertaken in different OR sites and farmers fields of RARS Nepalgunj, RARS Tarahara and RARS Parwanipur representing terai domain during the years 1998/99 to 2006/07 and OR sites of RARS Lumle, ARS Pakhribas and NPRP Khumal representing hill domains during the years 1996/97 to 2005/06. Results revealed that in the hills and terai both conditions, the tested clone was superior to all of the check varieties (Tables 6 and 7). Yield average of tested clone (CIP 388572.1k) in Terai was highest (28.9 t/ha), whereas farmer local produced 14.3, Desiree produced 19.9 and Kufri Sindhuri 19.8 t/ha, respectively. The yield was superior to all of the check varieties throughout the experimental years and experimental sites.

In the hills, the yield in all sites and experimental years was very high in the tested clone compared to all of the check varieties. Clone CIP 388572.1k produced 24.4 t/ha tuber yield, whereas in Khumal Seto-1, 17.8, Kufri Jyoti 19.1, NPI T/0012 15.7, Desiree 17.7 and farmers local 10.9 t/ha, respectively (Table 7). In terai on-farm trials, the average yield on tested clone was 102.4% higher than farmers' local, 45.2% higher than Desiree and 45.9% higher than Kufri Sindhuri (data not shown), whereas in the hills, this clone gave

37.1% higher yield than Khumal Seto-1, 27.7% higher than Kufri Jyoti, 55.4% higher than NPI T0012, 37.8% higher than Desiree and 123.8% higher than farmers' local (Table 7).

Table 6: On-farm yield performance of clone CIP 388572.1k compared to 3 check varieties under different OR sites of RARS from terai (1998/99 to 2006/07)

Clone	OR site Nepalgunj					OR site Tarahara				OR site Parwanipur		Average (t/ha)
	98/99	99/00	01/02	03/04	04/05	99/00	01/02	02/03	04/05	05/06	06/07	
388572.1	30.8	26.9	34.1	35.6	34.0	36.3	23.4	37.4	25.9	17.6	16.3	28.9
Local (ch)	16.9	21.6	-	-	-	11.8	-	-	-	-	6.9	14.3
Desiree (ch)	19.6	19.1	20.3	21.7	26.4	17.3	20.6	20.2	22.6	12.0		19.9
K.Sindhuri (ch)	15.0	18.9	23.1	25.9	22.4	23.3	16.2	27.3	22.5	12.0	11.4	19.8

Table 7: On-farm yield performance of clone CIP 388572.1k compared to 5 check varieties under different OR sites of ARS from hills from the year 1996/97 to 2004/05

Clones	OR site of Lumle			Farmers' fields of NPRP Khumaltar				OR sites of ARS Pakhribas		Average (t/ha)
	1996/97	97/98	04/05	97/98	98/99	03/04	05/06	96/97	97/98	
CIP 388572.1	39.1	30.6	21.5	25.5	26.2	20.3	23.2	19.2	14.3	24.4
Khumal Seto (ch)	25.7	24.3	-	22.3	-	-	-	10.2	6.6	17.8
K. Jyoti (ch)	28.9	26.5	-	20.6	20.7	17.4	18.8	11.6	8.7	19.1
NPI T/0012 (ch)	21.9	9.6	-	-	-	-	-	-	-	15.7
Desiree (ch)	-	-	17.7	-	20.8	16.3	16.0	-	-	17.7
Local (ch)	-	-	-	10.5	21.7	-	10.8	7.1	4.8	10.9

Table 8: Farmers' preference ranking on plant and tuber appearance, taste and yield of clone CIP 388572.1 compared to check varieties (1996/97 to 2004/05)

Clones	Farmers' preference ranking			
	Plant appearance	Tuber appearance	Taste	Yield preferences
CIP 388572.1	VG	VG	G	G
Desiree (ch)	VG	VG	VG	G
Kufri Sindhuri (ch)	G	F	G	G
Local (ch)	G	F	VG	F

Farmers' preference ranking: G= good, F= fair, VG= very good

Table 9. Farmers' preference ranking on plant and tuber appearance, taste and yield of clone CIP 388572.1k compared to check varieties (1996/97 to 2004/05)

Clones	OR sites ARS Pakhribas				OR sites RARS Lumle				Farmers' fields of NPRP Khumal			
	Plant	Tuber	Taste	Yield	Plant	Tuber	Taste	Yield	Plant	Tuber	Taste	Yield
CIP 388572.1k	VG	G	G	G	VG	G	G	VG	G	G	G	G
Kufri Jyoti (ch)	G	G	G	G	-	-	-	-	VG	G	F	F
Desiree (ch)	-	-	-	-	G	VG	VG	G	VG	G	G	G
Khumal Seto (ch)	G	G	G	G	-	-	-	-	-	-	-	-

Farmers' preference assessed on plant, tuber appearances, taste and yield at harvest from all of the OR sites revealed the results that the clone 388572k has almost similar preference to Desiree however, Desiree and farmers' local had comparatively better taste. Yield of this

clone was comparative to all of the check varieties (Table 8). Farmers local had comparatively inferior tuber yield.

Farmers' preference from OR site at ARS Pakhribas, RARS Lumle and NPRP Khumal from the hills showed that tested clone 388572.1k had comparatively better plants appearance than the checks (Table 9). All other parameters were also comparable.

CONCLUSION

On the basis of the superiority in plant growth, yield characteristics and farmers' preference including resistance level to the major diseases such as late blight and wart, clones CIP 388572.1k and CIP 388572.4k were proposed from NPRP for releasing on the occasion of International Potato Year 2008. Variety Approval, Release and Registration Subcommittee (VARRS) Nepal released clone CIP 388572.4k as "IPY-8" (the abbreviated form of International Potato Year-2008) and CIP 388572.1k as "Khumal Laxmi" (Laxmi, in the honor of late potato scientist Mr. Laxmi Prashad Khairegoli). Variety IPY-8 has been recommended for terai and inner terai cultivation and variety "Khumal Laxmi" can be cultivated successfully from terai to high hills. Both of these varieties were bred in International Potato Center (CIP), Lima, Peru and tested in Nepal following variety evaluation scheme of NPRP Khumaltar for several years. Both of these varieties are profitable and expected to give 3 to 6 tons higher tuber yield per hectare compared to the previously released potato varieties of Nepal and tolerant to late blight disease.

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