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FINAL REPORT

ON

STUDIES OF LATE BLIGHT OF POTATO AND TOMATO IN CHITWAN VALLEY, NEPAL (3A - 34)

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Abstract

Periodic survey of Western and Eastern Chitwan, Nepal indicated that the late blight disease of potato and tomato appears during beginning of November and reaches to epidemic proportion by the end of January.

The pathogen isolated from foliage of potato and tomato was *Phytophthora infestans*, however the isolate from the infected tomato fruit was more closer to *P. parasitica*.

Seeding of potato and transplanting of tomato seedlings early in the season i.e. during September may completely be excaped from the attack of disease, but the yield of potato was greatly reduced because of high soil temperature which supported more vegetative growth and low tuberization.

Varietal screening of potato and tomato indicated that the potato cultivars Kufri Jyoti, Kufri Badsaha, CIP-720088 were slightly resistant against the disease. In case of tomato non of the commercial cultivars were found resistant however, small fruting local tomato cultivars had shown some resistance.

Dithane M45 (0.5%) spraying at an interval of 4 to 7 days was found effective in controlling disease under low inoculum pressure. But under most favorable climatic conditions and high inoculum pressure it failed to protect the crop from the attack of disease.

Integrated control is the best suitable method for controlling the disease and successful cultivation of potato and tomato in Chitawan valley which included selection of cultivars, time of planting and spraying schedule. For potato Kufri Jyoti, Kufri Badsaha, CIP-720088 and Local Red could be planted during 2nd or 3rd week of October coupled with Ditham M45 (0.5%) spray just after the initiation of disease and repeated regularly after 4 to 7 days depending upon the climatic conditions. Similarly for commercial cultivation of tomato, Pusa Rubey, HS-101, Sel-TR_2 and for kitchen garden purpose Rampur Sano could be recommended for planting during August-September with the similar fungicidal spraying practice of potato.

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INTRODUCTION

Late blight of potato and tomato caused by the fungus Phytophthora infestans. Most. deBary is one of the most important diseases of potato and tomato throughout the world. In Northern India, the loss in yield of potato variety 'up-to-date' by this devastating disease was estimated between 21.2 to 52.7 percent (Dutta, 1962). In Nepal, it appears in epidermic proportion every year during winter season in Terai and Inner Terai regions and during summer season in the hills causing huge losses. The loss in yield was estimated 78.8 percent in case potato and it was found even upto 100 percent loss of tomato fruits depending upon the location and the variety used for cultivation. Heavy losses due to the late blight disease on potato in the hills during summer and in Kathmandu Valley during winter was also reported by Shrestha, 1976. Epiphytotic of late blight on tomatoes was observed in Nigeria during July - Sept. 1978 (Erinle and Quinn, 1980). It was observed since last several years that the disease appears in epidermic form on both potato and tomato during December through February in Chitwan valley of Nepal.

The Chitwan valley is one of the best potential area of Nepal for cultivating potato and tomato in commercial scale because it has sandy loam soil with optimum soil moisture, pH, temperature and easy market

facility for selling them. However, the only constrain for successful cultivation of these crops is the late blight disease. Consequently, management of the disease in Chitawan valley was felt urgent need to push up the economic conditions of the farmers of the valley. For this, detail study about the pathogen and different control measures were carried out.

For isolation and maintenance of pathogen Phytophthora infestans different techniques have been used. Cut potato tubers have been found commenly used for obtaining pure culture of the fungus. Selective antibiotic media for isolation of the fungus have also been developed (Eckort and Tsao, 1962) but it was found to be antagonistic to the P. infestans also. Lima bean agar medium was found best for isolation of the fungus. However, the pure cultures of the fungus was maintained in sugar-agar-rye slants by transferring a small piece of the culture from petridish. Another medium, a decoction containing Golden Bantam Sweet corn was found to maintain P. infestans for upto 12 months without transferring in fresh culture tubes and it was found no variation in virulence to potato (60th, 1981).

Since late blight of potato is a severe problem throughout the world, different scientists have tried to manage the disease from different angle so as to produce more yield. In Shilling, India, it was recorded that the losses in yield due to late blight disease

in summer season could very well be minimized in a susceptible variety "Up-to-date" by adjusting the planting time. Optimum time of planting lies in between last week of February and first week of March as the highest mean yield was obtained when the crop was planted on 27th February (Khanna and Vishwadhar, 1981).

Selection of variety resistant to late blight for planting in the farmers' field could be the most practical approach of controlling the disease. Therefore, level of field resistance was observed in released and pre-release varieties and 150 advance seedling clones derived from inter specific crosses of Solanum demissum under natural conditions of late blight epiphytotics at Shilling Plateau, India. Out of these but twenty five seedling clones were assessed for their field resistance to late blight. Twenty six seedling clones were identified as highly resistant and twenty seven fairly resistant. Race 3, 4 and 7 were found responsible for virulence in majority of varieties under study (Barua et. al., 1976). A potato variety "Gangweongyne 6" was developed by crossing frish cobbler and saco which was found highly resistant to late blight (Hahn et. al., 1979). It was described about the influence of host and pathogen genotypes on the apprent infection rates of potato late blight epidemics (Latin et. al., 1981).

Under field screening trial at IAAS, Rampur, Nepal, out of 43 tomato genotypes, non of them were found

resistant to P. infestans. However, Rampur Sano, local small fruited variety found moderately resistant and all the commercial cultivars were highly susceptible to late blight fungus (Sharma et. al., 1983). Another tomato genotype evaluation trial consisted of six F_2 segregating lines, three peruvianum lines, eleven esculentum cultivars including Rampur Sano and one pimpinellifolium line for resistance to late blight was established under natural epiphytotic conditions during winter of 1983. The disease caused the death of most of the plants in esculentum group but relatively fewer in peravianum and pimpinellifolium groups. After disease attack about 70% plants in Rampur Sano revived and produced normal healthy fruits. in one F_2-segregating line and two esculentum cultivars the percentage of revived plants was below 55. In other F_2-segregating lines and esculentum cultivars the percentage of revived plants were either very low or nill. The results indicated that peruvianum and pimpinellifolium lines had a higher level of resistancy to late blight than esculentum cultivars and F_2-segregating lines. it was also observed that Rampur sano had high level of recouping ability as compared to other esculentum cultivars (Upreti and Adhikari, 1984).

,Two types of late blight resistant have been identified (i) Monogenic and (ii) Polygenic in Meghalaya, India. The former being controlled by specific gene confers immunity against specific races and is liable

to be broken down in the presence of specialised races possessing matching genes while the polygenic resitant is controlled by a larger member of minor genes and is independent of such specialization. This means that a variety possessing polygenic resistance will get the infection of equal level from all the races whether simple or specialized but the rate of the progress of the disease will be reduced. A few of them found suitable for cultivation in Meghalaya are Kufri Jyoti, Kufri Naveen and Kufri Khasigaro (Barua, 1976).

In accordance with objective of the European Association for potato research to standardize tests for resistance to P. infestans, west German and Austrian cultivars were tested at 2 locations in which cultivars can be compared directly, independent of envirinmental factors (Schotier and Schies Sendoppler, 1983). They found that a complex NPK fertilizer applied at planting but not at later times, influenced the resistance of potato leaves to infection by P. infestans and the subsequent growth of lesions. Lesion size was directly correlated with increasing nitrogen application. Leaf position is also an important factor in determining leaf susceptibility to the disease and may substantially influence differences in susceptibility induced by fertilizer treatment.

Different scientists from different parts of the world recommended various fungicides to control late blight disease on potato and tomato. In the hills of

Nepal lonacol was reported to be effective incompacting late blight disease (Shrestha, 1976) and in the inner Terai regions 3 Sprays of Dithane Mus was found to reduce the disease (Bhardwaj et. al., 1981). However, ridomil, a systermic fungicide was found significantly superior than dithiocarbamates in controlling late blight disease of tomato (Shrestha and Bhrdwaj, 1980; and Singh and Garg, 1981). In the field trials with fungicides, the highest initial sprouting and final yield was obtained without seed pieces treated with Bavislin-50. They yield was only slighly more than that from whole untreated tubers (Sukla et. al., 1980). The systemic fungicide 'metalaxyl' effectively inhibited growth and development of P. infestans in potato foliage. The fungicide at law concentrations inhibited lesion appearance, expansion and sporulation from lesions (Bruk et. al., 1980). It was also observed that when ridomil applied to the soil or foliage controlled late blight. Further study made with Katandin tubers harvested from plants treated with metalayl and other conventional fungicides and found no evidence of fungal inhibition was observed in tubers sampled from plants treated with standard bungicides, but in tubers sampled from some metalaxyl treated plants growth and development of P. infestans was completely inhibited (Bhuti and Yaung, 1983).

Other new systemic fungicide Dex-3217 and Dupent curzate provided excellent curative as well as protectant activity at 80 mg a.i./lit. for the control of P.

infestans on tomato (Klopping and Delp, 1980). However, when several fungicides compared against P. infestans on tomato cultivars Money maker and Marglobe in Tanzania, Dithane Mu5 (mancozels) at 60g/10 litres, either alone or with DPX (unspecified) at 1.5g. gave the best results. The highest average yield was 44.25 ton/ha ie an increase of 12 ton/ha compared with unsprayed controls (Bujulu et. al., 1981). Although it was further suggested that Ridomil 25 WP was the most reliable fungicide against. P infestans best applied as tank mix with Kupricol-50 or ready mixed as Ridomil plus-50 WP or as Ridomil 2.72 WP so that resistance to it was less likely to develop (Lisba, 1983). However, the resistant isolates of the late blight pathogen was collected (Chohen and Reuveni, 1983). Recently, excellent control of late blight was found by using 4 or 5 spray sequence of cyprofuran + mancozeb at the rate of 1400g a.i./ha (Griffiths and Barness, 1984).

For efficient use of any fungicide in the field, a blight forecasting system for the particular locality should be developed and a campaign may be carried out for spraying effective fungicide so that the pathogen will not get chances of spreading and sporulating in that region. it is possible by weather monitoring, and regular field survey for several years to find out the possible time or conditions for appearance of the disease in the particular region. The system based on Blight cast was simplified for a pest management programme, field data and 6 years of weather records

from North Oceanic and Almos Admin were used to identify Blight cast components not contributing to forecasting accuracy. Seventy valued were thus, eliminated from the Blight cast criteria the recommended first fungicide application against P. infestans. Criteria eliminated from the Blight cast matrix that recommended subsequent sprays were max daily temp. 30°C, 5 day mean temp. 26°C and mini. daily temp. 7°C that nulls a blight favourable day (Hatter and Hardy, 1980).

Therefore, different aspects have been taken into consideration to study about this disease with the objective of managing the disease below economic level under Chitwan conditions. For this, its occurence, survival and the environmental factors that favour for the development of disease to epidemic proportion and different control measures through modification of environment, selection of resistant varities application of fungicide right amount at right time and integrated approach of disease control have been studied. All the field experiments were conducted at IAAS, Rampur, Chitwan, Nepal during the crop growing season of the years 1985/86, 86/87, 87/88 and 89/89.

MATERIALS AND METHODS

Survey Around Chitawan Valley:

Periodic survey around the plains of Eastern and Western Chitwan was done to find out the disease situation of potato and tomato in the farmers' field every year during the cropping period of these crops. About ten farmers from the East and ten farmers from the west were randomly selected for asking questions about the cultivation of these crops and the problems facing particularly due to disease.

Isolation of Pathogen:

Isolation of pathogen from potato tubers and foliage and tomato fruits and foliage was dose to study about their morphological characters for identification of species and also to find out the races. The infected samples of potato and tomato were brought to the laboratory, cut into small pieces with sterilized scissors or blade over the flame of spirit lamp. Those pieces were surface sterlized by dipping in the solution of 0.1% mercuric chloride for about 15 to 30 second and washed with sterilized distilled water twice and placed on the sterilized semi-solid media in the petridishes, under aseptic conditions using isolation chamber. Precautions were taken to avoid centamination of other fungi and bacteria. Different semi-solid media were used for isolating the pathogen, potato Dextrose Agar

(PDA), Yeast Extract Agar (YA), Czapexdox Agar (CA), Bean meal Agar (BA) and also the cut potato slices were used. The petridishes were then incubated for about 7 days at a temperature of 21± 1°C for 24 to 72 hrs for sporulation. Several temporary slides were prepared from those culture and also from the infected samples and their morphological characters were observed. Camera Lucida drawings of the sperangia were made by placing the slides under the compound microscope.

Effect of Planting Dates:

The potato cultivar 'Local Red' and the commercial tomato variety 'Pusa Rabey' were selected for this experiement. The potato tubers were sown at 10 days interval beginning from 21st September till 30th November during 1985 and 1986. The tomato seeds were sown in the nursery beginning from 31st August till 9th Novermber and the seedlings were trasplanted in the experimental plots after three weeks old. Therefore, both potato and tomato had 8 treatments and each treatment was replicated for 4 times to fit in the RCBD design. For each treatments disease incidence and severity were recorded on the basis of 0.5 point scale to find out the intensity of disease at three different dates and the average was taken for analysis.

Collection and Screening of Germplasms:

Fifty four potato cultivars/lines were collected from different locations or sources (Table-1) and were

Table - 1

Potato germplasms collected from different sources

S.No.	Potato Cultivars/Lines	Source
01	Beautex	NPDP/PAC
02	Hybrid-14	"
03	Desiree	"
04	Cardinal	"
05	Lumle Red	"
06	Var-I-1062	"
07	CFM	"
08	K-2305	"
09	CIP-575015	"
10	NPI-106	"
11	SIB-Z-408	"
12	Nepalgunj - 1	Nepalgunj district
13	Nepalgunj - 2	"
14	Kufri Sinduri	"
15	Deshi Red	"
16	Local Red	"
17	Local White	"
18	Dang Local	Dang district
19	Misuwa	Kaski district
20	Kaskikot local	"
21	Hayuja local	"
22	Lumle White	"

S.No.	Name of Potato Cultivars/Lines	Source
23	Deshi Safed	Rupandehi district
24	Deshi Red	"
25	Butwal Local	"
26	Sargam	Illam district
27	Birtamod White	"
28	Illam Red	"
29	Hiude	"
30	Pharasi	Dhankuta district
31	Dhankuta Red	"
32	Sarkari	"
33	Hale	"
34	Chhapadiya	"
35	Deshala	"
36	CIP-720088	NPDP/KTM
37	CIP-573275	"
38	CIP-3778315	"
39	Jaerala	"
40	Red Pontiac	"
41	Up-to-date	"
42	Kennebec	"
43	Sequola	"
44	Fatima	"
45	Cruza-27	"
46	BR 63/65	"
47	NPI-106	"

S.No.	Name of Potato Cultivars/Lines	Source
48	Pahenlo	Gorkha district
49	Seto	"
50	Rato	"
51	Kalo	"
52	Kufri Jyoti	Simla (India)
53	Nainital White	"
54	Local Red	Chitawan Valley

Table - 2

Tamato germplasms collected from different sources

S.No.	Name of Tomato Cultivars	Source
01	Illam Local - 1	Farmers' field Illam
02	Illam Local - 2	"
03	Illam Local - 3	"
04	Dhankuta Sano	Farmers' field Dhankuta
05	Dhankuta Majaula	"
06	Dhankuta Thulo	"
07	Dharan Local	Farmers' field Dharan
08	Adamghat Local	Farmers' field Pokhara
09	Mandi Local	Farmers' field Palpa
10	Palpa Local - 1	"
11	Palpa Local - 2	"
12	Tansen Local	"
13	Water melon-2-2-15-14	JADP, Janakpur, Nepal
14	Water melon-21-25-14	"
15	W-6-8-17-20-22-23-24	"
16	W-16-18-19-26	"
17	Marglobe 16-18-19-16	"
18	M-7-5-18	"
19	M-4-10-11-12-13-14-21-23-24	"
20	Pink Sturn-9-14-16	"
21	Pusa Early Dwarf	"
22	Pusa Rubey-12	"
23	Pusa Rubey Nepali	"

S.No.	Name of Tomato Cultivars	Source
24	Money Maker	NRIP, Parwanipur, Nepal
25	MAC	Hort Farm, Sarlahi, Nepal
26	BF 101	Hort Farm, Sarlahi
27	Marioka	"
28	Manaprecus	"
29	Ohlsen Enke No. 32	"
30	Solan Gola	"
31	Pusa Early Dwarf	"
32	Roma	"
33	Pusa Rubey	"
34	Marglobe	Nepalgunja Agricultural Center, Khajuri
35	Rampur Sano	Hort Farm, Rampur
36	Pusa Rubey Rampur	"
37	AC-451	G.V.P.U.A.T., Pantanagar (India)
38	AC-437	"
39	AC-72	"
40	AC-142	"
41	AC-111	"
42	AC-259	"
43	AC-282	"
44	AC-238	"
45	AC-192	"
46	Sel-22	"
47	Hyb-8	"

S.No.	Name of Tomato Cultivars	Source
48	Marutham	G.V.P.U.A.T., Pantanagar (India)
49	HT-8	"
50	Sel-T	"
51	pusa Rubey	"
52	Pusa Early Dward	"
53	Pusa Sel-2	"
54	J-10-2-2	"
55	CO-3	"
56	S-12	"
57	Sioux	"
58	Azad Kranti	"
59	Pant T-2	"
60	Pant T-3	"
61	Roma	HPKVV, Solan HP (India)
62	Punjab Chhura	"
63	Italian Red Pear	"
64	Best of All	"
65	Marglobe	"
66	Pusa - 120	"
67	Gaurav	"
68	S-12	"
69	Sioux	"
70	Pusa Rubey HP	"
71	Italian Red	"
72	CL 1131-0-0-3-8-1	Vegetable division, Khumaltar, KTM, Nepal.

S.No.	Name of Tomato Cultivars	Source
73	CL 1131-0-0-7-2-0-11	Vegetable Division Khumaltar, KTM
74	CL 5915-229 D4-1-1-0	"
75	CL 5915-153 D4-3-6-0	"
76	CL 5915-153 D4-3-3-0	"
77	CL 5915-223 D4-3-2-0	"
78	CL 5915-204 D4-2-2-0	"
79	Roma	"
80	Tropic-368-524	"
81	Chinese	"
82	No. 32	"
83	Solan Gola	"
84	Kurihara	"
85	Mapikit	"
86	Marikit	"
87	Pusa Rubey	"
88	Apollo	"
89	VC-45-1	"
90	VC-18-1	"
91	Pusa Early Dwarf	"
92	Manprecos	"
93	Point Roza	"
94	CL 5915-314 D4-1-1-0	"
95	CL 1131-0-0-13-0-6	"
96	CL 5915-39 D4-1-48	"
97	CL 5915-93 D4-1-0	"

S.No.	Name of Tomato Cultivars	Source
98	CL 5915-136 D4-1-0	Vegetable Division, Khumaltar, KTM, Nepal
99	Bel Takura Local	Dang, Nepal
100	Rajheni Local	"
101	Haripura Local	"
102	Punarbash Local	Nepalgunj, Nepal
103	Khajura Local	"
104	Garamuni Local	Jhapa, Nepal
105	PI-203230	U.S.A.
106	PI-203229	"
107	Rerd Cherry	"
108	Selection-01	Rampur, Chitawan, Nepal
109	Selection-02	"
110	Selection-3	"
111	Selection-04	"
112	2-2-6+3 Ind.	"
113	Kewalo D-Sel-1	"
114	Kewalo Ind-Sel-1	"
115	Thailand-2	Thailand
116	Fortune Fl Hyb	Taiwan
117	Farmers' 301 Hyb	"
118	379 Shiny Boy	"
119	84212	"
120	84203	"
121	84252	"
122	84256	"

S.No.	Name of Tomato Cultivars	Source
123	Roma	Rampur, Hort Farm, Nepal
124	Money Maker	"
125	Man Precus	"
126	No. 32 (OE)	Denmark
127	HS-101	Hissar (India)

screened during the main cropping season of 1985 and 1986-87 for their varying degree of resistance and susceptibility under natural field conditions against late blight disease. The disease incidence and severity were noted after 50, 65, and 80 days of sowing for each cultivars/lines to find out the intensity of disease and the average was taken for comparision. Similarly, hundred twenty seven tomato cultivars/lines were collected from different sources (Table 2) and transplanted in the experimental field from the nursery when the seedlings were 3 weeks old for natural infection with late blight pathogen, during the most susceptible period of blight in the year 1985 and 1986. the disease incidence and severity for each of the cultivars/lines were noted down on the basis of 0-5 point scale after 50, 70 and 90 days of trasplanting and average disease intensities were calculated for comparision of the cultivars/lines and to group them in different category.

Chemical Control:

Locally available non-systemic commercial fungicides Blitox-50 (0.3%) and Dithane Mus (0.3% and 0.5%) were sprayed over the foliage of potato 'Local Red' and tomato 'Pusa Rubey' at the interval of 6, 8, 10, 12 and 14 day. First spray was given when the initial symptoms of the late blight disease was observed in the experimental plots during the year 1985. The above

cultivars of potato and tomato were selected for this experiment because they were found susceptible to disease and were commercially cultivated by most of the farmers. During winter season of 1986, this experiment was repeated with slight modification of the treatments. blitox-50 (0.3%), Dithane 278 (0.3%) and Dithane Mu5 (0.3% and 0.5%) were sprayed over the foliage of potato and tomato at the interval of 4, 7 and 10 days. Each treatments were replicated 4 times. Disease incidence and severity were taken for trace different times on the basis of 0-5 point larbitory scale and average disease intensities were calculated for statistical analysis.

In all the above mentioned field experiments plant to plat and row to row distances for potato and tomato were maintained at 25x60 cm. and 50x75 cm., respectively and the size of the experimental units was 2.5x3 sq.m. except for germplasm screening trial for which the sizes were 3x1.8 sq.m. and 4x2.25 sq.m. for potato and tomato, respectively. The field was prepared by ploughing, harrowing and weeding before making the layout of the experimental plots. The fertilizers were applied at the rate of 100:80:60 Kg NPK/ha for potato and 140:80:60 Kg. NPK/ha for tomato through urea, complex and murate of potash on the top of FYm 200 Doko/Bigha (approx. 10 ton/ha.). The whole amount of phosphorus and potash was applied at the time of field preparation but nitrogen was applied in split doses. In case of potato 80 kg.

N/ha was applied at the time of field preparation and 20 kg. N/ha was given at the time of earthing up. in case of tomato also 80 kg. N/ha was applied at the time of field preparation but the remaining 60 kg. N/ha was further applied with split dose, 30 kg. N/ha after 25 days of transplanting the tomato seedlings and 30 kg. N/ha after 60 days of transplanting. Watering of the tomato seedlings was done at the time of transplanting till they got establishment and also while applying the nitrogenous fertilizers. No irrigation was given to the potato plants.

The (0-5) point arbitary scale was developed for scoring the diseases of potato and tomato, and was used the same throughout the experiments.

For Potato

0 = No disease

1 = less than 10% leaves of the plants infected with small lesions.

2 = 10-25% leaves of the plants infected with large lesions.

3 = 26-50% leaves of the plants infected with large lesions and slight infection on the stem (less than 10%).

4 = 51-75% leaves of the plants infected with large lesions and more infection on the stem (11-50%).

5 = More than 75% leaves of the plants infected with large lesions, stem infection more than 50%, plants plants going to die or dead.

For Tomato

0 = No disease

1 = Less than 10% leaves of the plants infected with smaller lesions.

2 = 11.25% leaves of the plants infected with larger lesions.

3 = 26-50% leaves of the plants infected with large lesions and upto 10% stems and fruits infected.

4 = 51-75% leaves of the plants infected with large lesions and 11-50% stems and fruits infected.

5 = More than 75% leaves of the plants infected with large lesions, more than 50% stems and fruits infected, plants going to die or dead.

Twenty plants for potato and ten plants for tomato were randomly selected to record disease intensity from each experimental units throughout the experiments. Percent disease intensity was calculated by utilizing the following formula:

$$\text{Disease intensity \%} = \frac{\text{Sum of all numerical rating}}{\text{No. of plants observed} \times \text{Maximum rating}} \times 100$$

In case of fungicidal trial the percent disease control was calculated by using the formula:

$$\text{Disease control \%} = \frac{\text{Disease intensity in control plot} - \text{Disease intensity in treated plot}}{\text{Disease intensity in control plot}} \times 100$$

In the field screening trial of potato and tomato cultivars/lines for natural infection with late blight

the susceptibility and resistant to disease was observed under following categories.

Disease intensity		Category of cultivars/lines
0%	=	immune
1-10%	=	resistant
11-25%	=	moderately resistant
26-40%	=	moderately susceptible
41-75%	=	susceptible
more than 75%	=	highly susceptible.

Integrated Control of Late Blight of Potato

Potato cultivars, Kufri Jyoti, Kufri Badsaha, Deseree and Local Red were sown in the field at three different dates (3rd Oct., 21st Oct., and 9th Nov., 1987) after preparing the field as mentioned above distances. Dithane M45 (Zinc ion 2% and manel 78%, i.e. manganous ethylenebisdithio carbamate) was applied two different doses (0.3% and 0.5%) at the interval of 4, 7 and 10 days. Control plot was maintained without spraying fungicide. The experimental field was layed down considering planting dates to put in the main plot, varieties in the subplot. So, double split design was used with four replications. The size of experimental units was 1.3 X 2.5 sq.m.

During cropping season of 1988/89 three cultivars of potato; Kufri Jyoti, Local Red and CIP-20088 were

planted in the experimental plots during last week of September and last week of October, 1988. Dithane M45 (0.3% and 0.5%) and Ridomil (0.1%) were used to spray at different time intervals to see their reaction with late blight disease and yield of potato.

Integrated Control of Late Blight of Tomato

Twenty different cultivars/lines of tomato, namely Rampur Sano, Sel-TR_2, Pusa Rubey, Sel-04, Dhankuta local, AC-72, AC-451, AC-142, AC-252, AC-111, Illam local 3, Pusa Early Dwarf, Kewalo (Ind.), Best of All, Marglobe, Dhankuta Majaula, 2-2-6+3 Ind., HS-101, PI-203229 and Sel-TR; were sown in the nursery bed during last week of August, 1988 and the seedlings were transplanted in the experimental plots after three weeks. Ditham M45 (0.3% and 0.5%) was applied at 4, 7 and 10 day interval and control plot was maintained without spray. Each treatment was replicated three times. Split plot design was applied to analyse the data recorded from each experimental units about disease intensity and marketable fruit yield. Tomato cultivars/lines were put in the main plot and fungicidal treatments in the sub-plot.

Efficacy of Ditham M45 against late blight of tomato under different environmental conditions were studied by planting the tomato variety Pusa Rubey in the experimental plots at four different dates and Ditham M45, two concentratious (0.3% and 0.5%) were applied

at 4, 7 and 10 day interval and control plot was kept without spray. The seeds of tomato were sown in the nursery on August 20, September 19, October 19, and November 18, 1987 and the seedlings ere transplanted in the experimental field after they were three weeks old. Data on disease intensity and fruit yield recorded from each experimental units were statistically analysed by using split plot design.

Five tomato cultivars; Pusa Rubey, Sel-TR_2, HS-101, AC-145 and Rampur Sano were transplanted in the experimental field during early season (third week of Sept., 1988). Sixteen cultivars/lines; Pusa Rubey, Rampur Sano, Best of All, Dhankuta Majaula, Marglobe, Roma, Sel-TR, Sel-TR_2, Illam local-3, HS-101, AC-142, AC-111, AC-72, AC-252, AC-451 and AC-282, the seedlings were transplanted during mid season (third week of Oct., 1988) and for planting late season (third week of Nov., 1988) four cultivars; Pusa Rubey, SelTR_2, HS-101 and AC-142 were taken. In all the cases three weeks old seedlings ere transplanted. For each seedlings 50X75 sq.cm. area was provided for their growth and development. Each cultivars/lines were replicated four times and were sprayed with Ditham M45 (0.3 and 0.5%), Ridomil (0.1%) alone and incombination at different time interval. Data on disease intensity and fruit yield were recorded for analysis.

Farmers' Field Demonstration

In the year 1988/89, two demonstration trials in the farmers' field were run. One in the Sarada Nagar Panchayat, Ward No. 10 and another Narayanpur Panchayat, Ward No. 2. Three plots of 15x9 sq.m. sized were asked to prepare to the farmers in their own field by ploughing, harrowing, weeding and adding 4 doko FYM/plot (ie approx. 10 ton/ha). Chemical fertilizers were supplied, measured amount so as to add NPK at the rate of 120:80:60 kgs/ha. Nitrogen was directed to apply in split dose, 80 kg/ha at the time of field preparation, 20 kg/ha after 30 days of transplanting the seedlings and 20 kg/ha after 60 days of transplanting. Tomato seedlings of Pusa Rubey, HS-101 and Sel-TR_2 were supplied for transplanting during third week of Sept. 1988. Dithane M was applied at the rate of 0.5% at 7 day interval at the begining of desease appearance and at 5 day interval during the most susceptible period. Marketable fruit yields were recorded for each of the cultivars.

Meteriological Data

Weekly average meteriological data maximum and minimum temperature, rainfall, humidily, dew amount and cloudy period were recorded from the begining of field experiments till the last of the experiment. Every year these data were recorded and represented in graphs to find out the correlation of these factors with the appearance of late blight disease reaching to epidemic proportions.

RESULTS AND DISCUSSIONS

Survey Around Chitawan Valley

A short survey around the plains of Eastern and Western Chitawan was taken during 1985/86 to find out the potato and tomato cultivation in the farmers' field and its situation concerning with the disease in the valley. Ten farmers from the East and tean farmers from the West Chitwan were visited and asked questions about the situation of potato and tomato cultivation in their fields.

During summer season no one was cultivating the potato and tomato in Chitawan Valley. Theyse crops are grown during winter season only, because summer months are not suitable for growing potato and tomato due to high temperature and heavy rainfall. In the East Chitawan the farmers were found cultivating potato quite extensively then the West Chitwan, also the cultivation of potato crop was found two to three weeks earlier in the east as compair to West. Neither in the East nor in the West the tomato crops were found cultivating extensively. Its cultivation was mostly limited to the Kitchen Garden. However, some farmers were found cultivating tomato covering larger areas for selling them in the local market. The potato and tomato crops were found to start cultivating from last week of September and continue upto the last week of November. These crops were found to grow mostly in uplands after the harvest of maize.

The farmers of Chitwan Valley were found very much worried of cultivating potato and tomato crops and they were compelled to cut off the area of cultivating these crops and some of the farmers had already given away this business. According to their version, the plants suddenly get killed due to heavy dew and winter rainfall. They were loosing 50 percent foliage of the potato plant due to heavy dew and 100 percent by winter rainfall. Winter fainfall is very much uncertain sometime it becomes heavy, sometimes light. It may come earlier or late in the winter. Consequently, cultivating potato and tomato crops was found very much risky game. Actually the plants were killed due to heavy attack of late blight disease but the farmers were found innocent to this disease. Some of the farmers told that the problem was because of introduction of nitrogenous fertilizer like Urea and extent of damage was worst in low lying area and wet soil.

All these indicated that the farmers were well experienced with the situations of disease out break but they were not knowing about the actual cause.

During the periodic survey of Chitwan Valley, it was found that the late blight disease on potato and tomato occurs invariably during winter season, mild to severe form, which is totally depended upon the environmental conditions. The early planted crops were observed less affected by the disease as compare to late

Farmer's potato field infected by
late blight disease in Eastern Chitawan valley

planted crops. The tomato plants were found more severely damaged than potato plants during December and January. The disease severely on potato was ranged 20 to 75 percent and on tomato 25 to 100 percent. It was also observed that the disease appears during beginning of November and reaches to epidemic proportion by the month of January.

Isolation and Maintenance of Isolates

The pathogen *Pytophthora infestans* causing late blight disease on potato and tomato were tried to isolate in the laboratory utilizing different media, like potato Dextrose Agar, Bean meal Agar, Oat meal Agar, Potato and Tomato leaf decoction agar and potato cut tubers. The pathogen was successfully isolated during winter on potato cut tubers for morphological studies but it could not stored for longer period because of lack of facilities. The temperature went high after winter in Rampur and the electricity oftenly went off which disturbed the storage conditions of the fungus.

Morphological characters of potato isolates and tomato isolates of *P. infestans* looks much similar. The mycelium had no differences. There was slight variation in the size of the sporangia. Variation in the sporangial size was also observed when the isolates were made from different varieties of either potato or tomato.

The isolates from tomato fruit had more pronounced papillated sporangia different from the isolates of

leaves. It could be another species of Phytopththora. The isolates from tomato fruit was found different from the P. infestans. The isolate was much similar with that of the P. parasitica.

Effects of Sowing Dates

Late blight succeptible potato variety 'Local Red' and tomato variety 'Pusa Rubey' were selected for studying the effect of sowing dates on late blight incidence and yield of these crops. The commercial cultivar of potato was sown at 10 days interval beginning from 21st September till 30th November and tomato was seeded in the Nursery bed also at 10 days interval beginning from 31st August till 9th November which were transplanted in the experimental plots after 3 weeks. Percent disease intensities and average yield (t/ha) were calculated for each sowing dates to see the effects of different planting time.

Early planting (21st Sept.) completely escaped the potato crop from thelate blight attack during 1985/86, but there was slight disease during 1986/87. The disease intensity was found in increasing trend with the delay in planting time up to 6th sowing dates (10th Nov.) and then again the disease attack was found to slidhtly decline. The disease intensity was recorded maximum (more than 90%) in the 10th and 20th Nov. sowing, however, the yield of the potato was minimum (3.6 t/ha) in the

Table - 3

Effect of planting dates on the incidence of late blight and yield of potato variety of 'Local Red'

Dates of sowing	Disease intensity (%) 1985/86	1986/87	Average yield (t/ha) 1985/86	1986/87
Sept. 21	0	12	14.0	12.8
Oct. 1	42	52	16.7	13.0
Oct. 11	58	66	19.8	15.3
Oct. 21	63	71	17.9	14.1
Oct. 31	74	82	14.7	10.2
Nov. 10	90	95	6.8	5.6
Nov. 20	96	98	4.5	4.3
Nov. 30	80	78	3.6	3.8
CD at 5%	1.41	2.30	1.15	0.98

last sown crop. Maximum yield (19.6 t/ha) was recorded from the 3rd planting (11th Oct.) whereas the yield was only 14.0 t/ha during 1985/86 and 12.8 t/ha during 1986/87 in the first planting (21st Sept.) even without having any late blight disease incidences. This could be because of high soil temperature during the period of tuberization and plant growth. In the last sowing, the yield was minimum despite of having less amount of disease incidence as compair to other dates of sowing which could be again because of high temperature, poor soil moisture content and attack of the plants by late blight at early state that did not allow the plant to grow vigerously. The increasing trend of disease with delay in planting could be explainted by the presence of favourable climatic conditions and inoculum built up. Khanna and Vishwadhar [1981] also mentioned that thelate blight disease incidence on potato could be minimized by adjusting the planting time.

From the beginning of December 1985 to the 3rd week of February 1986 and from the last week of November 1986 to 3rd week of February 1987, the maximum day temperature was in between 22 to 27°C and the minimum night temperature was in between 6 to 12°C and the relative humidity was always about 90% in this period. Beside these climatic conditions there was sufficient dew and morning fog till 9-10 a.m. All these conditions are very favourable for the development of disease in epidemic form.

Table - 4

Effect of seeding dates on the incidence of late blight and yield of tomato variety 'Pusa Rubey'

Seeding Dates	Percent disease intensity		Average yield t/ha	
	1986/86	1986/87	1985/86	1986/87
Aug. 31	28	31	65.67	63.52
Sep. 10	58	80	49.16	37.13
Sep. 20	90	92	14.92	10.86
Sep. 30	98	98	3.41	2.95
Oct. 10	100	100	0.0	0.0
Oct. 20	100	100	0.0	0.0
Oct. 30	100	100	0.0	0.0
Nov. 9	100	100	0.0	0.0
C.D. at 5%	1.5	0.96	1.44	0.95

In case of tomato var. 'Pusa Rubey' minimum disease incidence (28%) was recorded from the 1st seeded (August 31) crop with maximum yield (65.67 t/ha). As the seeding dates delayed the late blight disease incidences were increased and average yields were decreased significantly (Table 4). In later dates, (after October, 10) seeded crops the disease incidence was observed 100% and there was no marketable fruits harvested during 1985/86 and 1986/87. The epidemic of late blight disease was common in late planted crops of tomato. This was because of the inoculum built-up in the viscinity of the experimental plots beside the existence of favourable climatic conditions. The plants were attached at early vegetative growth stage and they were completely killed. This experiment clearly indicates that early planting can excape the heavy attack of late blight and good yield could be harvested in case of tomato.

Screening of Potato Germplasms

Potato germplasms were screened under natural epiphytotic conditions of late blight during the years 1985-86 and 1986-87 at the research field of Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan, Nepal. for this all the potato germplams collected from different sources were grown in the experimental plots with adquite fertilizer application and interculture operations during the main cropping season. Disease severity was recorded at three different growth stages

and average disease intensities for each cultivars were calculated. After harvesting the crop yield data were taken which are given in the table 5.

Out of fifty-four different potato cultivars/lines screened only three cultivars showed resistance. They were Kufri Jyoti, CIP-720088 and Jaerala. Other cultivars Dhankuta white, CIP-575015 and Cruza-27 showing moderately resistant during 1985-86 were found moderately susceptible during 1986-87. Hale was showing moderately susceptible. Rest of the cultivars were found either susceptible or highly susceptible to late blight disease incidence (Table 5). Although Kufri Jyoti yielded highest (13.48 t/ha during 1985-86) but the yield of other varieties ziz, Jaerala, Cruza-27, CIP-575015, CIP-720088, Hale and Dhankuta white was almost at par. Nepalgunj-2, Deshi Red, Local Red, Local White, Misuwa, CFM, Lumle Red, Beautex, Chhapadiya, Deshala, Sargam, CIP-3778315, Red Pontiac, Sequola, Pahelo and Fatima which were highly susceptible in the field during 1985-86, the tubers were completely rotted and no tubers were left for planting in the experimental field during 1986-87. There was more severe epiphytotic of late blight during the cropping season of 1986-87. The yield recorded very poor in susceptible and highly susceptible cultivars because the foliage was blighted severely before tuberization. in general, red skinned potato cultivars were more suscephble to late blight than the white skinned cultivars.

Table - 5

Field screening of potato cultivars/lines against natural infection with *Phtophthora infestans* and yield of potatoes.

S.No.	Potato Cultivars-Lines	Percent Disease Intensity		Average Yield (t/ha)	
		1985/86	1986/87	1985/86	1986/87
1.	Nepalgunj-1	90	96	5.35	3.35
2.	Nepalgunj-2	92	-	2.62	-
3.	Kufri Sindhuri	84	94	6.50	5.00
4.	Deshi Red	99	-	3.33	-
5.	Local Red	99	-	4.50	-
6.	Local White	99	-	2.08	-
7.	Dang Local	82	92	6.62	5.86
8.	Misuwa	99	-	3.33	-
9.	Deshi Safed	90	95	6.66	5.36
10.	Deshi Red	100	-	4.00	-
11.	K-2305	64	90	7.37	3.25
12.	Var-1-1062	68	95	6.08	2.15
13.	SIB-Z-408	84	98	5.00	3.00
14.	CFM	84	97	6.66	2.41
15.	Lumle Red	95	-	2.70	-
16.	Beautex	100	-	1.43	-
17.	Chhapadiya	95	-	3.11	-
18.	Deshala	95	-	3.33	-
19.	Sargam	95	-	3.43	-
20.	Birtamod White	38	47	9.99	8.12
21.	Illam Red	90	98	5.31	3.11

22.	Pharasi	80	85	5.83	3.50
23.	Hiude	86	88	4.11	3.00
24.	Dhankuta Red	70	80	5.16	4.10
25.	Dhankura White	16	30	12.32	9.89
26.	Hale	26	37	12.53	11.00
27.	Hayuja Local	34	40	8.77	6.52
28.	Lumle White	84	90	2.04	2.01
29.	Kaskikot Local	76	86	3.05	2.81
30.	Chitawan Local Red	94	95	3.69	2.99
31.	BR-63/65	80	90	6.55	5.38
32.	Hyb-14	70	88	4.57	3.10
33.	CIP-720088	10	18	13.00	12.32
34.	CIP-573275	40	65	6.89	4.51
35.	CIP-377831.5	94	-	3.33	-
36.	CIP-575015	12	31	12.18	9.37
37.	Sarkari	76	88	5.82	3.28
38.	Desiree	84	93	6.66	4.83
39.	Cruza-27	18	40	13.06	8.16
40.	Jaerala	10	20	12.15	11.52
41.	Red Pontiac	97	-	3.10	-
42.	Up-to-date	36	54	6.94	4.11
43.	Kennebec	48	62	6.89	3.89
44.	NPI-106	60	82	4.52	9.37
45.	Sequola	98	-	2.16	-
46.	Kufri Jyoti	8	12	13.48	11.86
47.	Cardinal	86	94	4.50	3.11
48.	Pahelo	92	-	3.89	-

49.	Rato	86	91	4.46	2.05
50.	Fatima	90	-	3.46	-
51	Seto	86	94	3.11	2.03
52.	Kalo	84	91	4.36	2.13
53.	Nainital White	78	80	5.21	4.11
54.	Darjeeling Red Round	88	94	5.11	3.26

The potato cultivars/lines showing either resistant or moderately resistant could be used more successfully in the field. these cultivars may replace the local variety in Chitawan valley during the successive years. However, it is better to combine other methods of disease control together with these cultivars since the Phytophthera infestans races development is quite frequent, which may be highly virulent in due course of time.

Screening of Tomato Germplasms

All the tomato germplasms collected from different sources were grown in the nursery bed and the seedlings were transplanted in the research plot of IAAS, Rampur when they were of about four weeks old. Required amont of fertilizers, irrigation, interculture operations were given. Disease intensities were calculated by taking the late blight incidence and severity on ten plants randomely selected for each of me cultivars/lines at three different intervals and the average is given in table 6. Number of plants revived after the heavy attack of disease are mentioned in percentage.

The climatic conditions during winters of 1985-86 and 1986-87 were very much favourable for the development of late blight disease in epidemic proportions. Consequently, all the 126 tomato cultivars/lines screened were found highly susceptible

to the disease. However, some cultivars had recouping capacity in later stage when the temperature increased and relative humidity decreased. Selection-04, selection 03, selection 02, selection 01, 2-2-6-Ind, Kewalo (Ind) Sel-1, Dhankuta local, Gdramuni local, AC-111, AC-142, AC-72, AC-451, Pusa Early Draft, Pusa Rubey, Marglobe, Best of All, Palpa local-2, Rampur sano, Dhankuta Majaula, Dharan local, MAC, A-282, Illam local-1, Illam local-3, HS-101, Ajad Kranti and Dhankuta Thulo had different degree of reviving ability but the highest recorping capacity more than 72% was observed in the Rampur Sano (Table 6). Similar findings with Rampur sano was also mentioned by Sharma et. al., (1983) and Upreti and Adhikari (1984). Most of the improved and hubrid varieties were completely killed by the disease. Fruits were also completely rotted before getting matured. Local small fruited cultivars, the stems remained survived when there was heavy attach of pathogen and new growth came later on which gave normal fruits.

The small fruited cultivars are useful for kitchen garden purpose but for commercial cultivation Pusa Rubey, HS-101, Ac-282, AC-451, Pusa Early Dwarf, Marglobe, Best of All and Dhankuta Majaula may be selected to combine with other methods of disease control for successful cultivation of tomato in Chitawan valley.

Table - 6

Field screening of tomato germplasms against natural epidemic of late blight during the year 1985/86 and 1986/87.

S.No.	Name of Cultivars/Lines	Disease Intensity (%)		Reviving (%)	
		1985/86	1986/87	1985/86	1986/87
1.	Roma	99.2	-	0.0	-
2.	No. 84256	99.5	-	0.0	-
3.	No. 84252	99.8	-	0.0	-
4.	No. 84203	99.6	-	0.0	-
5.	379 Shiny Boy	100.0	-	0.0	-
6.	Farmers' 301 Fi Hyb	100.0	-	0.0	-
7.	Fortune Fi Hyb	100.0	-	0.0	-
8.	No. 32 (O.E.)	100.0	-	0.0	-
9.	Manprecus	100.0	-	0.0	-
10.	Selection-04	98.0	99.0	10.0	8.0
11.	Selection-03	92.8	95.2	65.0	50.0
12.	Selection-02	93.0	96.0	45.0	35.0
13.	Selection-01	97.0	99.0	10.0	8.0
14.	2-2-6-Ind.	91.6	94.4	50.0	40.0
15.	Kewalo (I) Sel-1	89.5	92.6	35.0	30.0
16.	Kewalo (D) Sel-1	92.0	-	0.0	-
17.	Chinese	99.0	-	0.0	-
18.	Red Cherry	91.5	-	0.0	-
19.	Dhankuta Local	95.8	97.5	60.0	50.0
20.	Garamuni Local	94.9	96.8	30.0	20.0
21.	AC-259	92.4	-	0.0	-

22.	AC-111	89.5	94.2	30.0	25.0
23.	Khajura Local	92.0	-	0.0	-
24.	Punarbash Local	91.4	-	0.0	-
25.	Haripura Local	92.6	-	0.0	-
26.	Rajheni Local	95.0	-	0.0	-
27.	Beltakura Local	96.5	-	0.0	-
28.	AC-142	93.8	94.2	20.0	18.0
29.	AC-72	92.5	93.0	25.0	20.0
30.	AC-437	98.0	-	0.0	-
31.	AC-451	93.2	95.6	30.0	25.0
32.	CL-5915-314 D4-1-1-0	100.0	-	0.00	-
33.	Manprecus	99.6	-	0.0	-
34.	Pusa Early Dwarf	93.0	98.4	10.0	0.0
35.	VC-18-1	98.0	-	0.0	-
36.	VC-35-1	99.0	-	0.0	-
37.	Apollo	95.8	-	0.0	-
38.	Mapikit	96.2	-	0.0	-
39.	Solangola	99.2	-	0.0	-
40.	No.32	100.0	-	0.0	-
41.	Chinese	100.0	-	0.0	-
42.	Tropic-368-524	100.0	-	0.0	-
43.	Roma	95.0	-	0.0	-
44.	CL 5915-204 D4-1-2-0	98.0	-	0.0	-
45.	CL 5915-223 Dr-3-2-0	99.8	-	0.0	-
46.	CL 5915-153 Dr-3-3-0	100.0	-	0.0	-
47.	CL 5915-153 D4-3-6-0	100.0	-	0.0	-
48.	CL 5915-229 D4-1-1-0	100.0	-	0.0	-

49.	CL 1131-0-0-7-2-0-11	100.0	-	0.0	-
50.	CL 1131-0-0-3-8-1	100.0	-	0.0	-
51.	Pusa Rubey Rampur	91.5	92.8	50.0	40.0
52.	Pusa Rubey-12	92.0	-	0.0	-
53.	Marglobe	93.8	96.8	10.0	8.0
54.	Pusa Rubey Nepali	96.0	-	0.0	-
55.	Pusa Early Dwarf	94.2	97.0	15.0	10.0
56.	W-16-18-19-26	100.0	-	0.0	-
57.	M-7-5-18	100.0	-	0.0	-
58.	W-6-8-17-20-22-23-24	100.0	-	0.0	-
59.	M-4-10-11-12-13-14-21-23-24	100.0	-	0.0	-
60.	Watermelon-21-25-27	100.0	-	0.0	-
61.	Pinksturn-9-14-16	100.0	-	0.0	-
62.	Watermelon-2-2-25-14	100.0	-	0.0	-
63.	Money Maker	91.5	98.2	5.0	0.0
64.	Roma	99.0	-	0.0	-
65.	S-12	91.0	-	0.0	-
66.	Best of All	89.5	91.0	25.0	20.0
67.	Marblobe	89.5	95.0	10.0	8.0
68.	Pusa Gaurav	98.0	-	0.0	-
69.	Catalen	100.0	-	0.0	-
70.	Sioux	98.5	-	0.0	-
71.	Salimar-1	95.9	-	0.0	-
72.	Ox-heart	89.9	-	0.0	-
73.	Lalmani	93.2	-	0.0	-
74.	Solan Gola	100.0	-	0.0	-
75.	Adamghat Local	91.5	-	0.0	-

76.	Palpa Local-1	89.5	-	0.0	-
77.	Palpa Local-2	88.2	91.6	35.0	30.0
78.	Palpa Local-3	96.4	-	0.0	-
79.	Palpa Local-4	93.9	-	0.0	-
80.	Rampur Sano	86.8	89.0	75.0	72.0
81.	Dhankuta Majaula	98.2	99.0	25.0	20.0
82.	Dharan Local	91.5	95.8	35.0	30.0
83.	Marglobe	94.0	98.0	10.0	8.0
84.	Manprecus	100.0	-	0.0	-
85.	Roma	100.0	-	0.0	-
86.	Pusa Early Dwarf	92.0	86.5	15.0	10.0
87.	No. 32	100.0	-	0.0	-
88.	Marioka	100.0	-	0.0	-
89.	BF-101	100.0	-	0.0	-
90.	MAC	91.5	98.0	20.0	0.0
91.	AC-282	85.6	89.0	35.0	32.0
92.	HS-101	89.2	91.6	25.0	24.0
93.	Hyb-8	100.0	-	0.0	-
94.	Pant-T2	92.0	-	0.0	-
95.	Pusa Early Dwarf	93.4	96.0	10.0	8.0
96.	HT-8	90.8	-	0.0	-
97.	J-10-2-2	95.0	-	0.0	-
98.	Ajad Kranti	89.8	95.8	10.0	8.0
99.	Point Rosa	88.2	-	0.0	-
100.	CL-5915-39 D4-1-48	100.0	-	0.0	-
101	CL-5915-39 D4-1-0	100.0	-	0.0	-
102.	CL-5915-136 D4-1-0	100.0	-	0.0	-
103.	Solan Gola	100.0	-	0.0	-

104.	AC-282	91.2	93.0	15.0	12.0
105.	Selection-22	94.5	-	0.0	-
106.	Morutham	92.8	-	0.0	-
107.	Sel-T	89.5	-	0.0	-
108.	Pusa Sel-2	89.9	-	0.0	-
109.	S-12	91.5	-	0.0	-
110.	Sioux	99.5	-	0.0	-
111.	Punjab Chhura	89.5	-	0.0	-
113.	Pusa-120	98.2	-	0.0	-
114.	Pusa Rubey	94.5	95.0	15.0	12.0
115.	Marglobe	93.4	96.2	10.0	8.0
116.	Best of All	92.5	94.0	15.0	12.0
117.	Marutham	91.0	-	0.0	-
118.	Kurihara	100.0	-	0.0	-
119.	CL-5915-314 D4-1-1-0	100.0	-	0.0	-
120.	PI-203229	100.0	-	0.0	-
121.	PI-203229	100.0	-	0.0	-
122.	Dhankuta Thulo	92.0	95.6	15.0	12.0
123.	Illam Local-1	95.6	97.2	15.0	12.0
124.	Illam Local-2	94.2	-	0.0	-
125.	Illam Local-3	93.5	94.8	25.0	20.0
126.	Dhankuta Majaula	92.8	95.0	15.0	12.0

Effect of Fungicides:

Potato variety 'Local Red' and tomato variety 'Pusa Rubey' were grown in the experimental plots supplied with required amount of fertilizers, irrigation and interculture operations. The plants were started to spray just after the initiation of the disease in the visinity of experimental field of IAAS. Locally available fungicides Blitox-80 and Dithane M45 were applied with different concentrations and repeated at different time intervals. Control plot was maintained without any spray. Disease intensities were calculated at different growth stages and the average was taken for each treatments. Tuber yield of potato and fruit yield of tomato were taken and calculated in terms of tons per hectare.

Application of fungicides significantly reduced the incidence of late blight on potato as compare to control. Maximum disease was controlled by application of Dithane M45 at the rate of 0.5% at 6 day interval i.e., 66.0% during 1985/86 and 68.3% during 1986/87. The yield was also recorded maximum 21.1 t/ha and 23.4 t/ha during the respective years. With this treatment, however, it was quite near to that of the plants sprayed by Dithane M45 (0.3%) at 6 day interval. Minimum disease was controlled (around 12%) with Blitox (0.3%) at 14 day interval. The yield of potato tubers was observed negatively correlated with that of the late blight incidence, because as the indicence increased, the yield

was decreased and vice versa. Dithane M45 was found much superior as compare to Blitox-50. It is clear from the Table 7 that the interval of spray played important role than the concentration of Dithane M45 application. Spraying below 10 day interval was quite ineffective to suppress the disease.

Table - 7

Effect of fungicides application on the incidence of late blight and yield of potato.

Fungicide Concentration	Spray Inter-Val (Days)	Disease Intensity (%)		Disease Control (%)		Average Yield (t/ha)	
		1985/86	1986/87	1985/86	1986/87	1985/86	1986/87
Blitox-50 (0.3%)	14	73.3	83.3	12.0	11.7	6.3	4.1
" "	13	61.6	61.6	26.0	17.7	8.1	6.2
" "	10	56.6	57.1	32.0	32.7	11.5	8.9
" "	8	48.2	49.0	42.1	50.6	11.7	9.7
" "	6	45.7	45.0	45.1	47.1	13.9	11.0
Dithane M45 (0.3%)	14	55.0	54.0	33.9	36.6	9.3	8.0
" "	12	44.1	43.2	47.0	49.3	10.9	10.8
" "	10	43.3	42.1	48.0	50.6	13.2	13.3
" "	8	34.1	33.0	59.0	61.3	16.5	16.0
" "	6	30.8	30.1	63.0	62.2	20.3	19.1
Dithane M45 (0.5%)	14	46.5	46.1	44.1	45.9	9.8	9.7
" "	12	43.3	41.2	48.0	51.6	11.7	11.9
" "	10	40.8	39.9	51.0	53.2	14.3	15.0
" "	8	31.6	62.0	62.0	62.4	18.7	19.2
" "	6	28.3	27.0	66.0	68.3	21.1	23.4
Control (no spray)		83.3	85.3	0.0	0.0	3.9	3.2
C.D. at 5%		1.71	1.52	1.17	1.13	0.98	0.96

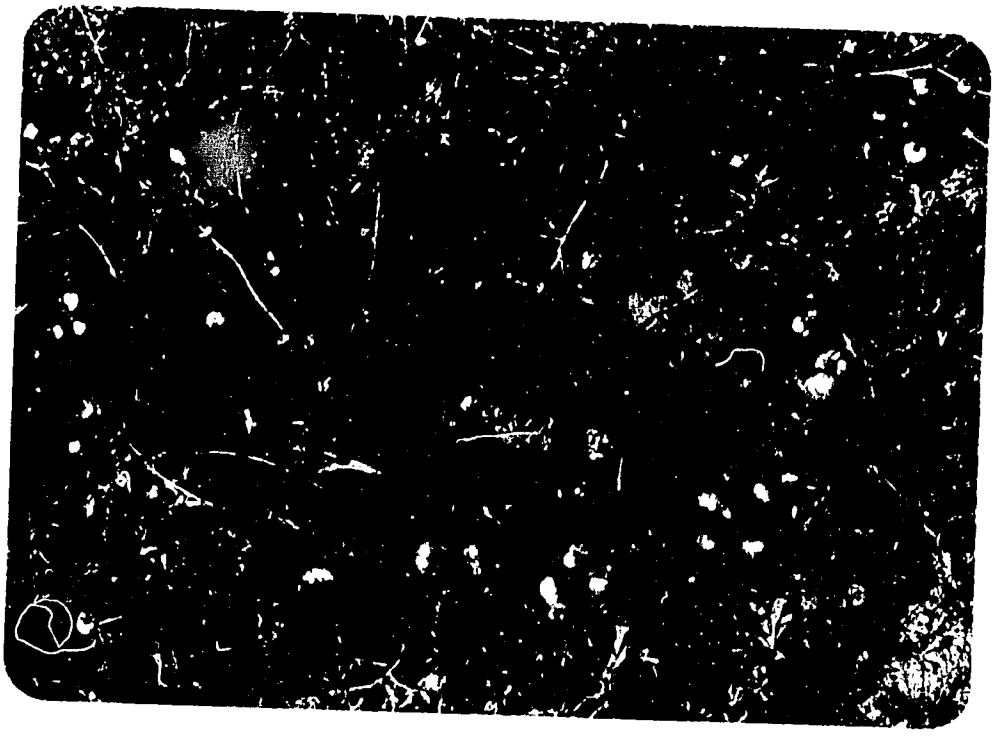
In case of tomato, although the disease pressure was significantly less in case of fungicide treated plants as compare to control, the disease intensity was not much suppressed. Highest late blight incidence was controlled by application Dithane M45 (0.5%) at 6 day interval (55 to 56.6%) and the yield was also recorded maximum more than 17 t/ha (Table 8). Dithane M45 was superior to Blitox-50 in reducing late blight incidence on tomato. blitox-50 (0.3%) spray at 14 day interval was found least effective which could reduce only about 3% disease intensity when compared with the control ie without application of any fungicide. Application of Dithane M45 either 0.3% at 6 day interval or 0.5% at 8 day interval was found almost at par to control the incidence of late blight. The disease intensity was recorded about 60% and 68% during 1985/86 & 1986/87, respectively at these concentrative and interval of spray.

Higher dose of Dithane M45 with short interval could suppress significantly the late blight incidence in tomato in Chitawan valley. The requirement of higher doses with frequent intervals in this valley to control late blight of tomato could be because of the presence of high amount of dew which dilute the chemical after application.

Table - 8

Effect of fungicides application on the incidence of late blight and yield of tomato.

Fungicide Concentration	Spray Inter-Val (Days)	Disease Intensity (%)		Disease Control (%)		Average Yield (t/ha)	
		1985/86	1986/87	1985/86	1986/87	1985/86	1986/87
Blitox-50 (0.3%)	14	96.6	96.8	3.4	3.2	3.26	3.69
" "	12	89.0	91.0	11.0	9.0	4.63	4.99
" "	10	84.6	86.6	15.4	13.4	5.43	5.68
" "	8	80.0	82.0	20.0	18.0	6.59	6.63
" "	6	78.0	76.5	22.0	23.5	7.33	7.50
Dithane M45 (0.3%)	14	71.3	79.3	28.7	20.7	7.98	7.60
" "	12	70.9	74.6	29.1	25.4	8.65	8.30
" "	10	66.6	66.9	33.4	33.1	10.37	10.26
" "	8	63.3	68.3	36.7	37.7	11.73	10.66
" "	6	60.6	66.6	39.4	33.4	14.19	13.40
Dithane M45 (0.5%)	14	70.0	72.8	30.0	27.2	7.36	7.96
" "	12	68.0	74.0	32.0	26.0	8.33	8.03
" "	10	63.3	70.5	36.7	29.5	10.36	10.33
" "	8	60.3	63.1	39.7	36.9	14.80	15.00
" "	6	55.0	56.6	45.0	43.4	18.79	17.06
Control (no spray)		100.0	100.0	0.0	0.0	2.87	2.50
C.D. at 5%		1.02	1.04	1.12	1.13	0.92	0.94



Late blight of tomato, showing infection on leaves, stems and fruit, unprotected plot at the IAAS, Rampur, Chitawan

Integrated Control of Late Blight of Potatoes:

Four potato cultivars, Kufri Jyoti, Kufri Badsaha, Deseree and Local Red were planted in the experimental plots on 3rd and 21st October and 9th November, 1987 and sprayed with Dithane M45 (0.3% and 0.5%) at 4, 7 and 10 day interval. Spraying was started just after the initiation of late blight disease in the visinity of ecperimental plots. In 1988, Kufri Jyoti, Local Red and CIP-720088 varieties were planted during last week of September and October and the plants were sprayed with Dithane M45 (0.3% and 0.5%) at 4 and 7 day interval, Ridomil (0.1%) at 14 day interval and Dithane M45 (0.5%) and Ridomil (.1%) at 7 day interval, alternatively to see the effects on late blight incidence and yield of potato.

Effect of Planting Date, Variety and Dithane M45:

The late blight disease intensity was recorded least in the early planted (3rd October) potato crops and it was found in increasing trend as the planting time is delayed, irrespective of varieties. Thus the highest disease was recorded from the last planted crops. The plants were almost escaped from the attack of pathogen during critical stages, resulting not much losses in yield due to disease while in case in late planted crops the disease was quite severe throughout the growing period of potato resulting into great reduction in tuber size and the average total yield (Table 9).

It is also indicated in Table 9 that the variety Deseree was the most succeptible to disease while the rest three Kufri Jyoti, Kufri Badsaha and Local Red were almost at par in their suceptibility to disease. However, highest yield was recorded in case of Local Red, followed by Kufri Badsaha, Kufri Jyoti and Deseree.

The fungicide Dithane M45 was found highly effective in reducing the severity of disease on potato as compare to control (without fungicide application). The interval of spray was found to play major role in reducing the disease because as the spray interval was increased the efficacy od controlling the disease was decreased. maximum disease was controlled in all the varieties of potato when Dithane M45 was applied at the rate of 0.5% at 4 day interval. It also gave maximum yield as compare to another concentration and interval of spray in all the cultivars of potato.

As the disease intensity increased the yield was decreased. It means they were negatively correlated. Highest average yield (53.9 t/ha) was obtained from the Local Red cultivare planted during 21st October and Dithane M45 praged at the rate of 0.5% at 4 day interval follwed by the same cultivar planted at the same time sprayed at the concentration at 7 day interval or 0.3% at 4 day interval and 0.5% at 10 day interval or 0.3% at 7 day interval. However, the most economical return was obtained from Kufri Badsaha and Local Red planted

Table - 9

Effect of planting dates, variety and Dithana M45 against late blight of potato.

Planting Dates	Potato Variety	Dithane M45 Conc. Spray Intraval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
		0.5% 4 day	8	71.40	34.6
		0.5% 7 day	10	64.26	29.9
		0.5% 10 day	13	53.55	25.3
	Kufri Jyoti	0.3% 4 day	10	64.26	31.3
		0.3% 7 day	12	57.12	27.9
		0.3% 10 day	15	46.41	24.6
		No spray	28	0.0	21.3
		0.5% 4 day	8	71.00	45.3
		0.5% 7 day	9	67.83	41.3
		0.5% 10 day	12	57.12	36.3
	Kufri Badsaha	0.3% 4 day	9	67.87	40.6
		0.3% 7 day	11	60.69	36.6
		0.3% 10 day	12	57.12	30.6
		No spray	28	0.0	23.3
October 3, 1987					
		0.5% 4 day	12	58.61	29.3
		0.5% 7 day	15	48.27	25.3
		0.5% 10 day	20	31.03	23.9
	Deseree	0.3% 4 day	14	51.72	25.3
		0.3% 7 day	18	37.92	23.9
		0.3% 10 day	24	17.24	20.6
		No spray	29	0.0	19.3
		0.5% 4 day	7	76.59	45.3
		0.5% 7 day	9	69.93	41.9
		0.5% 10 day	11	63.27	33.3
	Local Red	0.3% 4 day	9	69.93	35.9
		0.3% 7 day	10	66.60	29.3
		0.3% 10 day	14	53.28	27.3
		No spray	30	0.0	23.3

Contd...

Planting Dates	Potato Variety	Dithane M45 Conc. Spray Intraval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
	Kufri Jyoti	0.5% 4 day	10	71.25	34.6
		0.5% 7 day	12	65.55	29.3
		0.5% 10 day	15	57.00	23.3
		0.3% 4 day	14	59.85	25.9
		0.3% 7 day	19	45.60	23.9
		0.3% 10 day	25	28.50	22.6
		No spray	35	0.0	20.6
	Kufri Badsaha	0.5% 4 day	9	69.93	43.9
		0.5% 7 day	10	66.60	35.9
		0.5% 10 day	13	56.61	33.9
		0.3% 4 day	10	66.60	41.9
		0.3% 7 day	15	49.95	37.9
		0.3% 10 day	20	33.30	33.3
		No spray			
October 21, 1987					
	Deseree	0.5% 4 day	15	66.60	25.9
		0.5% 7 day	19	57.72	19.9
		0.5% 10 day	36	19.98	16.6
		0.3% 4 day	18	59.94	23.9
		0.3% 7 day	32	28.86	18.6
		0.3% 10 day	38	15.54	16.6
		No spray	45	0.0	15.3
	Local Red	0.5% 4 day	8	77.56	53.9
		0.5% 4 day	10	72.02	47.9
		0.5% 10 day	11	69.25	46.6
		0.3% 4 day	9	74.79	47.9
		0.3% 7 day	10	72.02	46.6
		0.3% 10 day	20	44.32	41.9
		No spray	36	0.0	23.3

Contd...

Planting Dates	Potato Variety	Dithane M45 Conc. Spray Intraval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
		0.5% 4 day	48	46.62	9.9
		0.5% 7 day	55	38.85	7.9
		0.5% 10 day	70	22.2	5.3
	Kufri Jyoti	0.3% 4 day	62	31.08	8.6
		0.3% 7 day	74	17.76	5.3
		0.3% 10 day	81	9.99	4.2
		No spray			
		0.5% 4 day	45	49.28	10.6
		0.5% 7 day	49	44.80	9.9
		0.5% 10 day	61	31.36	7.9
	Kufri Badsaha	0.3% 4 day	51	42.56	9.9
		0.3% 7 day	61	31.36	8.6
		0.3% 10 day	80	10.08	4.6
		No spray	89	0.0	3.1
November 9, 1987					
		0.5% 4 day	52	43.87	9.9
		0.5% 7 day	60	35.31	8.6
		0.5% 10 day	75	19.26	5.3
	Deseree	0.3% 4 day	60	35.31	7.9
		0.3% 7 day	78	16.05	5.3
		0.3% 10 day	81	12.84	4.6
		No spray	93	0.0	2.6
		0.5% 4 day	50	37.50	11.9
		0.5% 7 day	62	22.50	9.9
		0.5% 10 day	67	16.25	8.6
	Local Red	0.3% 4 day	60	25.00	10.6
		0.3% 7 day	70	12.50	8.6
		0.3% 10 day	72	10.00	7.9
		No spray	80	0.0	4.6

during October 3. The average yield on both cultivars was recorded 45.3 t/ha. In this case, the fungicide Dithane M45 was applied only in the later stages of the plant and only few number of sprays were applied which could control the late blight very efficiently because of low ineculum density during the main period of tuberization (Table 9). Kufri Badsala was observed even better than Local Red because the yield was recorded above 36 t/ha when the Dithane M45 applied at the rate of 0.5% at 10 day interval or 0.3% at 7 day interval on October 3 planted crop. Non of the cultivars and spray concentrations and intervals of spray could suppress the intensity of disease when planted on November 9 because of high inoculum density prevailing in the Chitawan valley during December through February. Therefore, the Kufri Badsaha and Local Red yielded less than 12 t/ha even after applying Dithane M45 0.5% at 4 day interval.

In the next season the three cultivars viz., Kufri Jyoti, Local Red and CIP-720088 were planted even earlier i.e. last week of September which resulted low disease intensity. Even without application of fungicides, the disease intensity was recorded below 16%, however, the yield was poor because of low soil fertility and too early planting which gave more of vegetative growth and less tuberization. It could be because of high soil temperature which affected the physiology of the plant. Maximum yield was recorded around 23 t/ha in case of

Kufri Jyoti and Local Red with below 4% disease intensity when sprayed with Dithane M45 (0.5%) at 4 day interval (Table 10). Ridomil has been reported as a very effective systemic fungicide for controlling late blight but at the present study it was found less effective as compare to Dithane M45 in the Chitawan valley. It could be because of new races developed in the country after the introduction of new potato varieties, which has resistance against the Ridomil. Lisba (1983) had also collected resistant isolates of late blight pathogen against Ridomil.

In the October last week planted crops of the above three cultivars lowest disease intensity (0.66%) and highest yield (28.58 t/ha) were obtained from Local Red cultivar sprayed with Dithane M45 (0.5%) at 4 day interval. It was followed by the same cultivar when sprayed at the rate of 0.3% at 4 day interval. Although all the fungicide treatments were reducing the disease seventy more than 50% as compare to control, but the Ridomil (0.%) at 14 day interval was found least effective in comparision with other treatments in controlling disease on Kufri Jyoti. However the application of Dithane M45 (0.5%) at 7 day interval, Ridomil (0.1%) at 7 day interval, alternately had similar effect in controlling disease of all the three cultivars and the yields were also almost at par with one another (Table 11). The tuber yield of privious year. This was because of changing the experimental block having lower soil fertility states.

Table - 10

Effect of varieties and fungicide sprays on late blight incidence and yield of potato, planted during last week of September, 1988.

Fungicide Spray	Disease Intensity (%)			Disease Control (%)			Yield (t/ha)		
	1	2	3	1	2	3	1	2	3
Dithane M45 (0.3%) at 4 day interval	4.1	5.7	4.5	72.10	62.73	66.36	21.77	20.47	18.85
Dithane M45 (0.3%) at 7 day interval	5.1	7.4	6.4	65.30	51.61	51.88	19.25	18.05	15.82
Dithane M45 (0.5%) at 4 day interval	3.2	4.4	3.8	78.25	71.34	71.07	23.27	23.25	20.77
Dithane M45 (0.5%) at 7 day interval	4.5	6.8	5.1	68.91	55.67	61.60	20.62	18.70	16.92
Ridomil (0.1%) at 14 day interval	6.6	7.3	7.6	54.95	51.93	43.12	17.15	18.07	14.45
Dithane M45 (0.5%) and Ridomil (0.1%) at 7 day interval, alternately	4.5	6.8	6.8	68.91	55.22	49.29	20.40	18.29	16.05
Control (No spray)	14.7	15.3	13.4	0.0	0.0	0.0	16.72	15.50	12.35

1 = Kufri Jyoti
2 = Local Red
3 = CIP-720088

These experiments clearly indicates that the late blight of potato could be managed very efficiently in Chitawan valley of Nepal by adopting integrated control approach. Kufri Badsaha or Kufri Jyoti varieties could be planted early in the season i.e. September last week to first week of October and depending upon the environmental conditions 3 to 5 sprays with Dithane M45 would control the disease without reducing much yield of potato tubers. Kufri Badsaha yields more than Kufri Jyoti in Chitawan valley. Local Red is long duration cultivar as compare to Kufri Jyoti and Kufri Badsaha. So, it gives more yield than other cultivars but it needs to be protected from the attack of disease by frequent spraying with Dithane M45.

It is clear from the present studies that the efficient of fungicide in controlling the disease is greatly reduced when the inoculum density of pathogen is high. Therefore, all the farmers of Chitawan valley should start spraying at a time so that the pathogen may not get chance to mutiply the spores for increasing the inoculum density in the valley.

Late blight forecasting system if implemented would become very helpful for the management of late blight disease in Chitawan valley. Once the inoculum density builds up and the climatic conditions become very favourable, then it is not possible to control the disease. In such situation even the resistant varieties of potato get infection.

Table - 11

Effect of varieties and fungicide sprays on late blight incidence and yield of potato, planted during last week of October, 1988.

Fungide Spray	Disease Intensity (%)			Disease Control (%)			Yield (t/ha)		
	1	2	3	1	2	3	1	2	3
Dithane M45 (0.3%) at 4 day interval	9.66	8.00	10.00	65.80	76.90	67.60	22.70	27.96	24.59
Dithane M45 (0.3%) at 7 day interval	12.66	14.33	12.66	55.70	58.30	59.70	20.58	25.52	21.79
Dithane M45 (0.5%) at 4 day interval	8.00	5.66	8.33	71.90	83.60	72.90	24.52	28.58	26.44
Dithane M45 (0.5%) at 7 day interval	12.33	11.33	12.00	56.50	67.20	61.69	21.92	25.29	23.30
Ridomil (0.1%) at 14 day interval	15.33	12.66	12.66	46.20	63.40	59.50	19.60	24.45	23.28
Dithane M45 (0.5%) and Ridomi (0.1%) at 7 day interval, alternately	12.33	12.00	11.00	56.50	63.47	64.50	22.02	25.56	23.03
Control (No spray)	28.66	34.66	31.33	0.0	0.0	0.0	10.63	12.40	13.07

1 = Kufri Jyoti
2 = Local Red
3 = CIP-720088

Effect of Seeding Dates and Dithane M45 on Late Blight of Tomato:

For this study four seeding dates (20th August, 19th September, 19th October and 18th November) were selected for raising the seedling to tomato variety 'Pusa Rubey' in the nursery beds. The seedlings were then transplanted in the experimental field after three weeks of seeding. Required amount of fertilizers, irrigation water and interculture operations were given. The fungicide Dithane M45 (0.3% and 0.5%) was sprayed by compression sprayer at 4, 7 and 10 day interval. Spraying was started just after the initiation of late blight in the Chitawan valley. Disease severities were recorded at three different growth stages (maximum vegetative growth stage, max. flowering stage and max. fruiting stage) for each of the treatments and average percent disease intensities were calculated. Healthy marketable fruit yields were taken for each treatments and calculated in terms of tons per hectare.

In general, as the seeding dates were delayed, the plants were attacked more severely by the disease. The 20th August seeded plants had only 33% average disease intensity and more than 90% disease intensity was recorded for later dates when the plants were not protected by the fungicide. The marketable fruit yield was 24 t/ha from the 1st seeded plant which was reduced to only 6.3 t/ha and 5.3 t/ha from 2nd and 3rd seeded plants, respectively. There was no marketable fruits at all from the last seeded plants without protection by fungicide (Table 12).

Table - 12

Effect of planting dates and Dithane M45 against Late blight of tomato variety 'Pusa Rubey'

Tomato Seeding Dates	Dithane M45 Conc.	Interval &(day)	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
August 20, 1987	0.5%	4	0.0	100.0	56.0
	0.5%	7	0.0	100.0	54.0
	0.5%	10	4.0	87.0	47.3
	0.3%	4	0.0	100.0	55.6
	0.3%	7	0.0	100.0	54.6
	0.3%	10	5.0	84.0	48.0
	No spray		33.0	0.0	24.0
September 19, 1987	0.5%	4	0.0	100.0	56.9
	0.5%	7	8.0	91.4	47.8
	0.5%	10	28.0	70.2	26.3
	0.3%	4	6.0	93.6	50.6
	0.3%	7	12.0	85.4	43.3
	0.3%	10	30.0	68.0	26.3
	No spray		94.0	0.0	6.3
October 19, 1987	0.5%	4	20.0	79.1	20.7
	0.5%	7	60.0	37.5	14.6
	0.5%	10	70.0	27.0	10.1
	0.3%	4	30.0	68.7	18.1
	0.3%	7	55.0	38.7	12.2
	0.3%	10	80.0	16.6	7.0
	No spray		96.0	0.0	5.3
November 18, 1987	0.5%	4	35.0	65.0	15.2
	0.5%	7	60.0	40.0	11.0
	0.5%	10	80.0	20.0	5.2
	0.3%	4	50.0	50.0	9.7
	0.3%	7	85.0	15.0	4.1
	0.3%	10	90.0	10.0	4.9
	No spray		100.0	0.0	0.0

The yield of tomato fruit was above 56 ton/ha when seeding was done befor 26th September, 1987 and sprayed with Dithane M45 (0.5%) at 4 day interval. However, October and November seeded plants got heavy attack by the disease and ever after spraying with Dithane M45 at the rate of 0.5% at 4 day interval could not save the plants. The yield was reduced greatly. The fruits also got infection and roted. This was because of prevailing heavy inoculum density of Phytophthora infestans sporangia in the environment, beside the climatic conditions were much favourable for the development of disease. In such conditions, the Dithane M45 became ineffective. However, August and September seeded plants could save very effectively by spraying with proper dose and proper time interval of spay and gave good yield.

August seeding was found the most economical for the farmers of Chitwan Valley, because the Late blight disease appears late during fruiting period of the plants and can be very effectively controlled by spraying Dithane M45. Therefore, the crop losses will be minimized with low investment in produring fungicide. Seeding during 3rd week of August and transplanting after 3 weeks in the field with 3 to 5 spray of Dithane M45 (0.5%) can be recommended to the farmers of Chitwan Valley for economic return. By planting tomato at the above recommended period, a farmer can earn 3 to 4 fold more income than cultivating rice from the same acerage.

Effect of Tomato Varieties and Dithane M45 Against Late Blight Disease:

Out of twenty varieties of tomato sel-TR2 gave highest yield 84.39 t/ha, when the plants were sprayed with Dithane M45 at the rate of 0.5% with 4 day interval. Tomato varieties Pusa Rubey, AC-142 and HS-101 were quite comparable and gave average yield of 57.59, 52.53 and 58.39 t/ha with the same treatment. These varieties were found quite potential after sel-TR2. Dithane M45 when applied at the rate of 0.5% at 4 day interval could control late blight disease more than 75 percent. In each variety Dithane M45 could supressed the disease to some extent as compare to control (without Dithane M45 spray). As the percent disease intensity increased the yield of tomato fruit was decreased in each variety. in some variety, the disease was suppressed quite effectively by the fungicide but the yield was not comparable to other varieties. It was quite low, such as, sel-04, Illam local III. The maximum yield of these varieties were, 15.99 and 12.79 t/ha, with the reduction of disease severity by 78.75 and 75.03 percent, respectively. Rest of the varieties gave nearly similar yield with the same type of treatment. This indicates, the variety sel-TR2 has certain capacity to tolerate the disease and has got highest potential for production in Chitwan area. This variety was selected from the population of Pusa Rubey but it has certain different characters which do not fit with Pusa Rubey. Plant height dwarft type, semideterminent growth habit, heavy flowers and fruit size

medium, smooth surface almost sperical type. AC-142 was found slightly tolerate to disease and also heat, so it has also got certain potential for growing late or early in the season which will allow to escape the disease severity. Because of heavy dew the fungicide is diluted in Chitwan condition requiring higher doses and also the time interval should not be more for spraying specially during the period of December through February to sppress the severity of late blight disease in tomato. Details are given in Table 13.

Table - 13

Effect of tomato varieties and Dithane M45 against late blight disease.

Totato Variety	Dithane M45 Conc.	Spray Interval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
Rampur Sano	0.5%	4 day	20	52.36	26.13
	0.5%	7 day	22	47.60	25.06
	0.5%	10 day	26	38.08	21.33
	0.3%	4 day	22	47.60	25.59
	0.3%	7 day	24	42.84	22.39
	0.3%	10 day	32	23.80	19.19
	No spray		42	0.0	16.26
Sel-TR2	0.5%	4 day	18	53.76	84.39
	0.5%	7 day	20	48.64	63.33
	0.5%	10 day	24	38.40	49.73
	0.3%	4 day	20	48.64	74.26
	0.3%	7 day	23	40.96	52.66
	0.3%	10 day	28	28.16	45.46
	No spray		39	0.0	24.66
Pusa Rubey	0.5%	4 day	15	66.60	57.59
	0.5%	7 day	21	53.28	50.38
	0.5%	10 day	29	35.52	39.45
	0.3%	4 day	22	51.06	49.85
	0.3%	7 day	29	35.52	42.12
	0.3%	10 day	30	33.30	37.05
	No spray		45	0.0	22.66
Sel-04	0.5%	4 day	17	78.75	15.99
	0.5%	7 day	20	75.00	8.53
	0.5%	10 day	62	22.50	4.53
	0.3%	4 day	20	75.00	9.86
	0.3%	7 day	50	37.50	5.86
	0.3%	10 day	78	2.50	2.66
	No spray		80	0.0	2.39

Contd...

Tomato Variety	Dithane M45 Conc.	Spray Interval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
Kewalo (I)	0.5%	4 day	21	61.05	20.79
	0.5%	7 day	25	53.65	19.73
	0.5%	10 day	31	42.55	18.15
	0.3%	4 day	23	57.35	19.72
	0.3%	7 day	29	46.25	19.19
	0.3%	10 day	36	33.30	16.26
	No spray		54	0.0	9.86
Best of All	0.5%	4 day	16	64.38	25.06
	0.5%	7 day	20	55.50	23.46
	0.5%	10 day	30	33.30	15.99
	0.3%	4 day	16	64.38	23.99
	0.3%	7 day	28	37.74	17.86
	0.3%	10 day	31	31.08	17.59
	No spray		45	0.0	5.33
Marglobe	0.5%	4 day	18	69.29	31.46
	0.5%	7 day	20	65.91	22.39
	0.5%	10 day	28	52.39	19.19
	0.3%	4 day	20	65.91	21.06
	0.3%	7 day	32	45.63	17.06
	0.3%	10 day	36	38.87	14.39
	No spray		59	0.0	4.79
Dhankuta Majaula	0.5%	4 day	20	65.36	28.53
	0.5%	7 day	24	58.48	24.26
	0.5%	10 day	32	44.72	17.59
	0.3%	4 day	20	65.36	24.79
	0.3%	7 day	28	51.60	22.13
	0.3%	10 day	38	34.40	10.39
	No spray		58	0.0	5.06

Contd...

Totato Variety	Dithane M45 Conc. Spray Interval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
	0.5% 4 day	20	75.00	26.13
	0.5% 7 day	36	55.00	23.46
	0.5% 10 day	56	30.00	10.13
Dhunkuta Local	0.3% 4 day	20	75.00	26.87
	0.3% 7 day	36	55.0	23.99
	0.3% 10 day	60	25.00	8.79
	No spray	80	0.0	4.53
	0.5% 4 day	16	68.00	39.99
	0.5% 7 day	26	48.00	35.99
	0.5% 10 day	28	44.00	34.13
AC-72	0.3% 4 day	24	52.00	37.33
	0.3% 7 day	30	40.00	31.99
	0.3% 10 day	41	18.00	24.26
	No spray	90	0.0	10.66
	0.5% 4 day	12	74.88	34.93
	0.5% 7 day	18	62.40	30.66
	0.5% 10 day	24	49.92	30.13
AC-451	0.3% 4 day	14	70.72	34.93
	0.3% 7 day	20	58.24	26.39
	0.3% 10 day	25	47.84	23.99
	No spray	48	0.0	11.73
	0.5% 4 day	16	74.06	52.53
	0.5% 7 day	20	67.62	47.99
	0.5% 10 day	28	54.74	37.06
AC-142	0.3% 4 day	20	67.62	46.66
	0.3% 7 day	24	61.18	46.66
	0.3% 10 day	40	35.42	28.79
	No spray	62	0.0	10.39

Contd...

Totato Variety	Dithane M45 Conc. Spray Interval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
AC-252	0.5% 4 day	18	62.40	26.39
	0.5% 7 day	25	47.84	14.39
	9.5% 10 day	26	45.76	13.59
	0.3% 4 day	20	58.24	21.86
	0.3% 7 day	25	47.84	15.19
	0.3% 10 day	28	41.60	11.99
	No spray	48	0.0	5.33
AC-3	0.5% 4 day	16	69.12	36.53
	0.5% 7 day	20	61.44	22.39
	0.5% 10 day	24	53.76	14.66
	0.3% 4 day	20	61.44	22.39
	0.3% 7 day	22	57.60	17.06
	0.3% 10 day	30	42.24	10.93
	No spray	52	0.0	4.79
Illam Local 3	0.5% 4 day	20	75.03	12.79
	0.5% 7 day	27	66.42	9.59
	0.5% 10 day	58	28.29	5.86
	0.3% 4 day	22	72.57	10.66
	0.3% 7 day	28	65.19	8.79
	0.3% 10 day	60	25.83	6.93
	No spray	81	0.0	2.93
Pusa Early Dwarf	0.5% 4 day	20	64.08	22.93
	0.5% 7 day	26	53.40	20.79
	0.5% 10 day	30	46.28	19.99
	0.3% 4 day	21	62.30	21.33
	0.3% 7 day	27	51.62	19.99
	0.3% 10 day	39.16	17.33	17.33
	No spray	56	0.0	6.66

Contd...

Totato Variety	Dithane M45 Conc. Spray Interval	Percent Disease Intensity	Percent Disease Control	Average Yield t/ha
2-2-6+3 Ind.	0.5% 4 day	16	72.24	29.59
	0.5% 7 day	22	61.92	25.06
	0.5% 10 day	29	49.88	16.26
	0.3% 4 day	20	65.36	25.06
	0.3% 7 day	30	48.16	17.59
	0.3% 10 day	32	44.72	15.99
	No spray	58	0.0	9.33
HS-101	0.5% 4 day	18	59.02	58.39
	0.5% 7 day	26	40.86	30.13
	0.5% 10 day	32	27.24	27.73
	0.3% 4 day	20	54.48	49.59
	0.3% 7 day	28	36.32	24.26
	0.3% 10 day	32	27.24	22.39
	Bo spray	44	0.0	6.39
PI-203229	0.5% 4 day	25	73.84	23.99
	0.5% 7 day	30	68.64	20.53
	0.5% 10 day	42	56.16	15.19
	0.3% 4 day	32	66.56	19.99
	0.3% 7 day	44	54.08	12.79
	0.3% 10 day	52	45.76	10.66
	No spray	96	0.0	2.66
Sel-TRI	0.5% 4 day	20	56.42	32.79
	0.5% 7 day	22	52.08	28.79
	0.5% 10 day	30	34.72	23.46
	0.3% 4 day	21	54.25	29.06
	0.3% 7 day	28	39.06	23.99
	0.3% 10 day	36	21.70	16.52
	No spray	46	0.0	10.13

Integrated Control of Late Blight of Tomato:

For this study different varieties of tomato were grown in the Nursery bed for three weeks and the seedlings were transplanted in the experimental plots. Three different planting dates were selected and the plants were sprayed with different concentration of fungicide at different spray interval.

Among the five selected varieties (Rampur Sano, Pusa Rubey, Sel-TR2, HS-101 and AC 145) transplanted during the third week of September, 1988. HS-101 gave maximum yield (53.42 t/ha) followed by Sel-TR2 (52.92 t/ha), Pusa Rubey (46.77 t/ha), AC 145 (46.28 t/ha), and Rampur Sano (38.70 t/ha) when the plants were sprayed with Dithane M45 (0.5%) at 4 day interval continuously just after the emergence of the disease in the field, although minimum disease (below 9%) was recorded on HS-101 and AC 145 (Table 14). All the treated plots with fungicide has significantly less desease as compare to untreated plot irrespective of tomato varieties. Disease severity was found directly corelated with the marketable fruit yield of tomato.

In this experiment, the variation of percent disease intensities was less among the different treatments, however the variation in yield was found more because the disease appeared late in the cropping season which resulted into less damage of the foliage but there was

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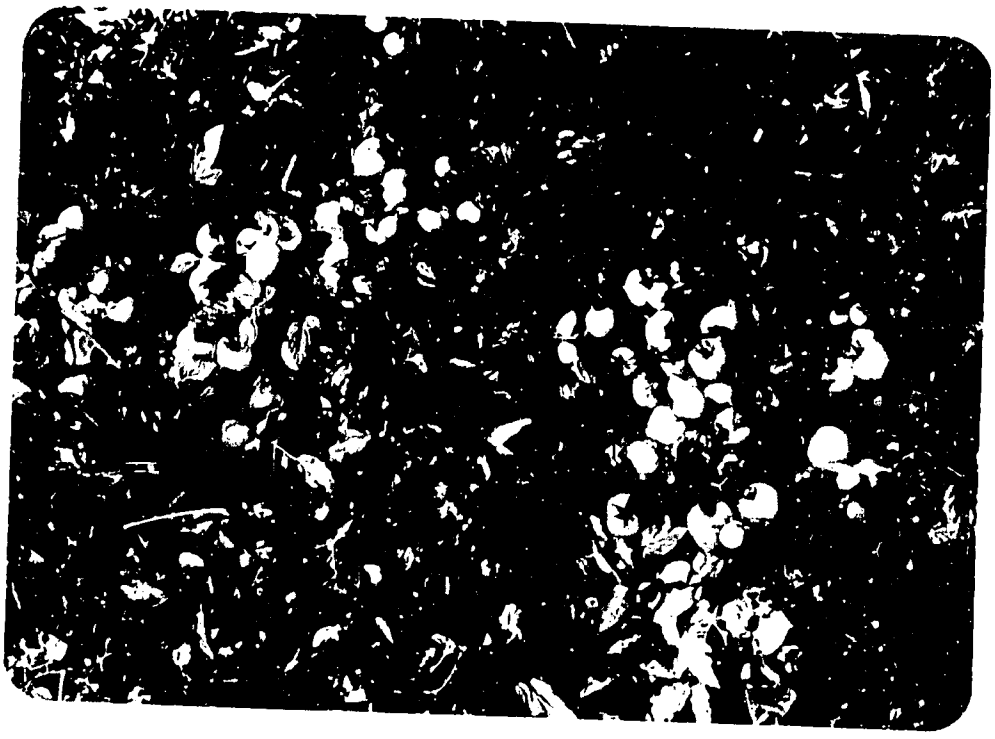

Tomato variely HS-101
One of the potential variety for
commercial cultivation

Table - 14

Effect on late blight incidence and yield of tomato varieties sprayed with fungicides, transplanted during third week of September, 1988.

Treatments		Percent Disease Intensity	Percemt Disease Control	Yield t/ha
Potato Variety	Fungicide (Conc.) Spray Interval			
Rampur Sano	Dithane M45 (0.3%) at 4 day	17.53	37.20	29.39
"	Dithane M45 (0.3%) at 7 day	19.76	29.21	21.11
"	Dithane M45 (0.5%) at 4 day	11.32	59.43	38.70
"	Dithane M45 (0.5%) at 7 day	15.87	43.11	25.55
"	Ridomil (0.1%) at 14 day	21.53	22.89	20.61
"	Ridomil (0.1%) and Dithane M45 (0.5) at 7 day alternatively	19.04	31.85	23.14
"	No spray	27.93	0.0	15.96
Pusa Rubey	Dithane M45 (0.3%) at 4 day	17.19	35.81	26.16
"	Dithane M45 (0.3%) at 7 day	19.82	25.98	21.20
"	Dithane M45 (0.5%) at 4 day	11.18	58.22	46.77
"	Dithane M45 (0.5%) at 7 day	18.09	32.43	26.19
"	Ridomil (0.1%) at 14 day	20.49	23.44	22.60
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	18.12	32.33	21.30
"	No spray	26.78	0.0	14.97

Sel-TR_2	Dithane M45 (0.3%) at 4 day	15.41	44.47	28.61
"	Dithane M45 (0.3%) at 7 day	17.75	36.02	23.71
"	Dithane M45 (0.5%) at 4 day	11.15	59.81	52.92
"	Dithane M45 (0.5%) at 7 day	16.59	40.19	34.80
"	Ridomil (0.1%) at 14 day	22.18	20.05	25.72
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	18.27	34.14	25.06
"	No spray	27.75	0.0	15.07
HS-101	Dithane M45 (0.3%) at 4 day	11.82	52.28	45.95
"	Dithane M45 (0.3%) at 7 day	17.44 17.44	29.51 29.51	33.63
"	Dithane M45 (0.5%) at 4 day	8.94	63.87	53.42
"	Dithane M45 (0.5%) at 7 day	14.67	40.63	36.97
"	Ridomil (0.1%) at 14 day	17.29	30.05	27.25
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	15.24	38.31	30.50
"	No spray	24.77	0.0	16.00

AC 145	Dithane M45 (0.3%) at 4 day	11.78	52.48	39.46
"	Dithane M45 (0.3%) at 7 day	15.94	35.73	29.67
"	Dithane M45 (0.5%) at 4 day	8.84	64.34	46.28
"	Dithane M45 (0.5%) at 7 day	13.34	46.21	33.62
"	Ridomil (0.1%) at 14 day	15.30	38.32	25.28
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	14.15	42.95	27.38
"	No spray	24.80	0.0	15.38

more fruit rots at the harvesting time. As a result the marketable fruit yield was greatly reduced. To protect the fruits timely spray with Dithan M45 must be given that will increase the marketable fruit yield.

Sixteen different tomato cultivars viz; Pusa Rubey, Rampur Sano, HS-101, Sel-TR2, Best of All, AC-142, AC-111, Illam local-3, Dhankuta Majaula, Mar globe, AC-72, AC-252, AC-451, Sel-TR1, AC-282, and Roma were transplanted during third week of October, 1988. In all these cultivars, spraying with fungicide significantly reduced the attack of late blight disease as compare to control (Table 15). Highest marketable fruit yield was recorded from Sel-TR2 followed by HS-101, Pusa Rubey, Rampur Sano, AC-142, AC-281, AC-451, Sel-TR1, AC-111, Illam local-3, Dhankuta Majaula, Best of All, Roma, Marglobe, AC-252 and AC-72. Maximum disease was controlled by Dithane M45 (0.5%) spray at 4 day interval in all these cultivars. There was 80-90% disease intensity when the plants were not sprayed with any fungicide. Spraying with Dithane M45 (0.3%) at 4 day interval and the same (0.5%) at 7 day interval has almost equal capacity in controlling the disease. Spraying with system fungicide Ridomil (0.1%) at 14 day interval was found least effective among the treatments. Fruit rotting was quite high when the spraying interval was kept at 7 day interval. Some of the fruits were rotted because of Fusarium and Rhizoctonia particulary those lying on the wet soil. However, maximum fruit not was caused by Phytopthara.

Table - 15

Effect on late blight incidence and yield of varities of tomato sprayed with fungicides, planted during week of October, 19988.

Treatment		Percent Disease Intensity	Percent Disease Control	Yield t/ha
Potato Variety	Fungicide (Conc.) Spray Interval			
Pusa Rubey	Dithane M45 (0.3%) at 4 day	22.0	76.45	20.37
"	Dithane M45 (0.3%) at 7 day	26.0	72.15	18.34
"	Dithane M45 (0.5%) at 4 day	16.6	81.13	27.06
"	Dithane M45 (0.5%) at 7 day	24.0	74.36	21.03
"	Ridomil (0.1%) at 14 day	38.6	71.91	18.41
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	42.6	60.95	16.12
"	No spray	93.3	0.0	3.69
Rampur Sano	Dithane M45 (0.3%) 14 4 day	20.0	77.78	20.03
"	Dith			
"	Dithane M45 (9.3%) at 7 day	27.6	69.28	16.87
"	Dithane M45 (0.5%) at 4 day	16.6	81.45	24.77
"	Dithane M45 (0.5%) at 7 day	22.0	75.57	19.54
"	Ridomil (0.1%) at 4 day	33.6	62.60	18.89
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day interval alternatively	48.0	46.81	15.83
"	No spray	90.0	0.0	7.50

NS-101	Dithane M45 (0.3%) at 4 day	20.3	76.33	24.70
"	Dithane M45 (0.3%) at 7 day	29.3	65.91	19.96
"	Dithane M45 (0.5%) at 4 day	18.6	78.24	31.94
"	Dithane M45 (0.5%) at 7 day	23.3	72.80	21.59
"	Ridomil (0.1%) at 14 day	38.0	55.77	20.30
"	Ri			
"	Ridomil (0.1%) Dithane M45 (0.5%) at 7 day alternatively	42.6	50.18	14.94
"	No spray	86.0	0.0	8.24
Sel-TR_2	Dithane M45 (0.3%) at 4 day	20.6	74.90	35.18
"	Dithane M45 (0.3%) at 7 day	28.0	66.15	30.27
"	Dithane M45 (0.5%) at 4 day	18.0	78.20	38.72
"	Dithane M45 (0.5%) at 7 day	24.0	70.99	31.48
"	Ridomil (0.1%) at 14 day	38.0	54.09	30.22
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	41.0	50.56	21.45
"	No spray	82.6	0.0	7.94
Best of All	Dithane M45 (0.3%) at 4 day	20.0	77.76	8.17
"	Dithane M45 (0.3%) at 7 day	29.3	67.48	7.13

Best of All	Dithane M45 (0.5%) at 4 day	16.6	81.47	12.65
"	Dithane M45 (0.5%) at 7 day	23.6	73.71	7.29
"	Ridomil (0.1%) at 14 day	34.6	61.43	5.23
"	Ridomil (0.1%) Dithane M45 (0.5%) at 7 day alternatively	43.3	51.84	4.54
"	No spray	90.0	0.0	3.06
AC-142	Dithane M45 (0.3%) at 4 day	16.0	80.10	23.87
"	Dithane M45 (0.3%) at 7 day	22.6	73.32	21.53
"	Dithane M45 (0.5%) at 4 day	14.6	82.52	26.96
"	Dithane M45 (0.5%) at 7 day	19.3	77.0	22.45
"	Ridomil (0.1%) at 14 day	22.6	73.02	16.22
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	28.3	66.28	14.39
"	No spray	84.6	0.0	5.34
AC-111	Dithane M45 (0.3%) at 4 day	18.6	78.07	15.23
"	Dithane M45 (0.3%) at 7 day	21.3	74.92	12.86
"	Dithane M45 (0.5%) at 4 day	14.6	82.74	21.16
"	Dithane M45 (0.5%) at 7 day	21.3	74.92	17.29
"	Ridomil (0.1%) at 14 day	25.3	70.18	12.85

AC-111	Ridomil (0.1%) Dithane M45 (0.5%) at 7 day altervatively	44.0	48.97	10.41
"	No spray	86.0	0.0	6.16
Illam Local III	Dithane M45 (0.3%) at 4 day	16.6	80.99	16.40
"	Dithane M45 (0.3%) at 7 day	21.3	75.79	14.35
"	Dithane M45 (0.5%) at 4 day	14.6	83.30	18.34
"	Dithane M45 (0.5%) at 7 day	20.0	77.24	15.37
"	Ridomil (0.1%) ato 14 day	24.0	72.75	13.30
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	35.3	59.82	13.15
"	No spray	88.0	0.0	4.34
Dhankuta Majaula	Dithane M45 (0.3%) at 4 day	20.0	75.65	14.67
"	Dithane M45 (0.3%) at 7 day	24.6	70.19	12.51
"	Dithane M45 (0.5%) at 4 day	19.3	76.51	18.06
"	Dithane M45 (0.5%) at 7 day	24.0	71.04	13.19
"	Ridomil (0.1%) at 14 day	32.6	60.45	9.14
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	38.0	53.87	7.30
"	No spray	82.6	0.0	3.34

Marglobe	Dithane M45 (0.3%) at 4 day	18.6	78.48	8.13
"	Dithane M45 (0.3%) at 7 day	26.0	70.64	6.30
"	Dithane M45 (0.5%) at 4 day	13.3	84.87	9.78
"	Dithane M45 (0.5%) at 7 day	20.0	77.09	7.26
"	Ridomil (0.1%) at 14 day	29.3	66.55	5.20
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	38.0	56.69	4.59
		38.0	56.69	4.59
"	No spray	88.6	0.0	2.12
AC-72	Dithane m45 (0.3%) at 4 day	14.6	81.36	6.30
"	Dithane M45 (0.3%) at 7 day	18.0	52.39	4.93
"	Dithane M45 (0.5%) at 4 day	11.0	86.12	7.66
"	Dithane M45 (0.5%) at 7 day	18.0	77.06	6.21
"	Ridomil (0.1%) at 14 day	21.3	73.44	4.89
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	32.6	59.10	4.01
"	No spray	80.6	0.0	2.51
AC-252	Dithane m45 (0.3%) at 4 day	13.3	83.39	7.57
"	Dithane M45 (0.3%) at 7 day	18.0	77.69	5.71
"	Dithane M45 (0.5%) at 4 day	10.0	87.45	8.45

AC-252	Dithane M45 (0.5%) at 7 day	16.6	79.43	6.25
"	Ridomil (0.1%) at 14 day	28.0	64.82	5.43
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	36.0	55.28	3.96
"	No spray	80.6	0.0	2.46
AC-451	Dithane M45 (0.3%) at 4 day	16.6	79.31	10.04
"	Dithane M45 (0.3%) at 7 day	21.3	73.56	15.87
"	Dithane M45 (0.5%) at 4 day	14.0	82.67	23.93
"	Dithane M45 (0.5%) at 7 day	18.6	76.91	17.61
"	Ridomil (0.1%) at 14 day	22.6	71.90	15.51
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	28.0	65.35	9.25
"	No spray	80.6	0.0	3.68
Sel-TR_1	Dithane M45 (0.3%) at 4 day	16.6	78.80	17.33
"	Dithane M45 (0.3%) at 7 day	19.3	75.42	15.22
"	Dithane m45 (0.5%) at 4 day	14.0	82.18	21.42
"	Dithane M45 (0.5%) at 7 day	19.0	75.78	15.70
"	Ridomil (0.1%) at 14 day	23.3	70.46	14.05

Sel-TR_1	Ridomil (0.1%) and Dithane m45 (0.5%) at 7 day alternatively	38.0	51.71	9.77
"	No spray	78.6	0.0	3.72
AC-282	Dithane M45 (0.3%) at 4 day	16.6	79.71	20.87
"	Dithane M45 (0.3%) at 7 day	20.3	75.19	18.64
"	Dithane M45 (0.5%) at 4 day	15.0	81.66	25.09
"	Dithane M45 (0.5%) at 7 day	20.0	75.69	19.94
"	Ridomil (0.1%) at 14 day	29.3	64.46	38.06
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	30.0	63.20	15.58
"	No spray	82.6	0.0	6.73
Roma	Dithane M45 (0.3%) at 4 day	20.0	77.11	8.00
"	Dithane M45 (0.3%) at 7 day	23.3	73.25	7.64
"	Dithane M45 (0.5%) at 4 day	18.6	78.71	11.05
"	Dithane m45 (0.5%) at 7 day	22.0	74.91	7.93
"	Ridomil (0.1%) at 14 day	36.6	58.09	5.89
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	44.0	49.22	4.34
"	No spray	88.0	0.0	2.38

The results of late planted (third week of November, 1988) tomato cultivars, Rampur Sano, Pusa Rubey, Sel-TR_2 and AC-145 is given in Table 16. In this case, although the fungicidal treatment reduced the disease intensity in all these cultivars but the yield was greatly reduced. Maximum yield recorded from Pusa Rubey was 14.07 t/ha, when the plants were sprayed with Dithane M45 (0.5%) at 4 day plants were sprayed with Dithane M45 (0.5%) at 4 day interval. The reduction in average yield was because of the early attack by the pathogen P. infestans. The plants could not grow vigerously because of continuous attack by the pathogen despite of continuous fungicidal spray. There was great inoculum pressure from the viscinity of the experimental plots. Non of the tomato cultivars could withstand and produce more yield while planting late in the season.

From these experiment it is clear that earlier planting during September with the regular spray at 4 to 7 day interval could be most effective to suppress the disease and get more yield. Higher concentration of Dithane M45 (0.5%) is required to be sprayed in Chitawan valley for controlling late blight of potato and tomato because of heavy dew formation during the cropping season of these crops. The tomato varieties, HS-101, Sel-TR_2 and Pusa Rubey could be recommended for commercial cultivation in Chitawan valley. However for kitchen garden purpose 'Rampur Sano' could be recommended. For

Healthy fruits of tomato harvested from the successfully managed plots through integrated approach

Table - 16

Effect on late blight incidence and yield of tomato varieties sprayed with fungicides, transplanted during third week of November, 1988.

Treatments		Percent Disease Intensity	Percent Disease Control	Yield t/ha
Potato Variety	Fungicide (Conc.) Spray Interval			
Rampur Sano	Dithane M45 (0.5%) at 4 day	22.66	75.60	7.0
"	Dithane M45 (0.5%) at 7 day	31.33	66.23	3.93
"	Dithane M45 (0.3%) at 4 day	30.00	67.67	5.45
"	Dithane M45 (0.3%) at 7 day	40.66	56.87	3.15
"	Ridomil (0.1%) at 14 day	46.66	45.36	1.60
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	32.66	64.80	3.17
"	No spray	92.66	0.0	0.91
Pusa Rubey	Dithane M45 (0.5%) at 4 day	22.00	75.56	14.07
"	Dithane M45 (0.5%) at 7 day	35.33	61.04	7.22
"	Dithane M45 (0.3%) at 4 day	26.66	70.49	10.29
"	Dithane M45 (0.3%) at 7 day	40.66	55.23	6.25
"	Ridomil (0.1%) at 14 day	45.33	50.14	4.57
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	38.00	58.12	5.48
"	No spray	91.33	0.0	2.04

Sel-TR_2	Dithane M45 (0.5%) at 4 day	25.33	72.79	9.07
"	Dithane M45 (0.5%) at 7 day	32.00	65.72	6.00
"	Dithane M45 (0.3%) at 4 day	30.00	67.84	7.55
"	Dithane M45 (0.3%) at 7 day	51.33	45.23	4.43
"	Ridomil (0.1%) at 14 day	70.66	25.09	3.03
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	34.00	63.60	5.03
"	No spray	94.00	0.0	1.63
AC-145	Dithane M45 (0.5%) at 4 day	22.66	75.60	10.43
"	Dithane M45 (0.5%) at 7 day	42.66	54.00	4.76
"	Dithane M45 (0.3%) at 4 day	31.33	66.23	7.76
"	Dithane M45 (0.3%) at 7 day	43.33	53.27	4.36
"	Ridomil (0.1%) at 14 day	55.33	40.31	2.62
"	Ridomil (0.1%) and Dithane M45 (0.5%) at 7 day alternatively	46.00	50.39	4.43
"	No spray	92.66	0.0	1.57

successful cultivation planting time, selection of varieties and spraying schedule which include concentration of fungicide and spray interval are important. So the integrated control approach is only method for successful management of the late blight disease in Chitawan valley.

Demonstration Trials in Farmers' Field

To demonstration trials on tomato late blight control were put in the farmers' field of Sarada Nagar and Mangalpur Village Panchayat and one demonstration trial on potato late blight control was pur in Sarada Nagar Village Panchayat during 1988-89. The fields were prepared by the farmers and FYM was added. NPK were supplied at the rate of 80:60:60 kg/ha for potato planting and 120:60:60 kg/ha for tomato planting through urea, triple super phosphate and murate of potash. Urea was applid in split doses but other fertilizers were applied at the time of field preparation.

Two varieties of potato (Local Red and Kufri Jyoti) were seeded on 2nd week of October weeks old seedlings of three tomato varieties (Pusa Rubey, RS-101 and Sel-TR_2) were transplanted in the field during 2nd week of September. Spacing for potato was maintained at 60 X 25 sq. cm. and for tomato it was 75 X 50 sq. cm. Four sprays for potato and six sprays for tomato were given with Dithane M45 (0.5%) at 7 day interval from the date of late blight appearance in the vicinity.

This year late blight was appear about a month later than the pastyears. Four sprays of Dithane M45 (0.5%) could control the potato plants every effectively. The disease intencity was below 5 percent till the plants get matured. Local red was found about three weeks late in getting maturity as compare to 'Kufri Jyoti'. Nevertheless, the yield of Local Red was one-third time more than Kufri Jyoti. The Local Red yielded 30 t/ha where as Kufri Jyoti yielded 22 t/ha.

All the three varieties of tomato were grown quite successfully in both the locations. The late blight disease was noted below 10 percent in al the varieties. There was no fruit infection with the disease. Pusa Rubey, HS-101 and Sel-TR_2 could be grown commercially because all these varieties are high yielder. All these varieties exceed 28 t/ha fruit yield in the farmers' field.

With this results the farmers' are very much encouraged. They would like to put more area under cultivation of tomato crops in the coming years. Other farmers who visited the demonstration trials in farmers' field also found interested in cultivating of this crops in their farms.

Epidemology of Late Blight in Chitawan Valley

The late blight disease was appeared both on potato and tomato simultaneously during last week of November 1985 and 1986, and reached to epidemic proportion by second week of January 1986 and 1987. During this period the maximum day temperature was below 25°C and minimum night temperature was below 10°C. There was slight rain during last week of December. The relative humidity was above 98% with morning fog upto around 11 AM. There was lot of dew formation during this period. These climatic conditions favoured for the development of disease in epidemic form in Chitawan valley. The heavy attack of disease continued upto the end of February 1986 and 1987. But the disease was observed on potato and tomato crops upto end of March, although the temperature rised up and relative humidity greatly decreased. This could be because of heavy inoculum built up during the January and February. Bashi et al. (1982) and Kroll and Eide (1981) also mentioned the importance of inocolum concentration and the development of late blight of potato.

The appearance of late blight disease on potato and tomato was noticed during last week of December in 1987 and 1988. This was actually a month later than the usual time of its appearance in Chitawan valley. The disease was observed in epidemic form by 2nd week of January 1988 and 1989, but the severity of disease was observed more during 2nd and 3rd week of February

in 1989. This could be again because of slight rain fall during this period.

The temperature remains favourable during winter season in Chitawan valley for the development of late blight disease, but for the severity of the disease winter rain is very important because whenever the winter rain falls after one or two days, we find very severe attack of disease. This studies cleared that the climatic conditions are critical for the development of disease severity. This will help to develop late blight forcasting model in Chitawan valley and warning to the farmers for applying fungicide would help for effective control of late blight disease on potato and tomato. Nutter and Hardy (1950) also mentioned the importance of disease forcasting and fungicidal control.

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Annex - 1/1

Meteriological Data (Weekly Average)

1985/86

Date	Temperature Max.C	Temperature Min.C	Relative Humdity (%)	Rainfall in mm	Morning Fog upto (A.M.)	Cloudy Sky
1st week of Stpt. 1985	32.42	24.57	96.14	24.78	-	Mostry Partial
2nd week of Sept. 1985	34.28	24.00	80.71	10.61	-	Mostly Clear
3rd week of Sept. 1985	33.28	22.28	86.57	14.34	-	Mostly Partial
4th week of Sept. 1985	32.28	22.28	86.42	8.52	-	Mostly Partial
1st week of Oct. 1985	32.71	22.14	84.00	-	-	Mostly Clear
2nd week of Oct. 1985	30.28	21.14	87.85	18.57	-	Mostly Partial
3rd week of Oct. 1985	30.28	18.85	86.85	6.85	-	"
4th week of oct. 1985	31.00	15.71	84.57	-	8-10	Mostly Clear
1st week of Nov. 1985	30.28	14.85	89.71	-	8-9	Clear
2nd week of Nov. 1985	28.28	13.85	88.71	-	8-9	"
3rd week of Nov. 1985	29.71	11.14	94.25	-	7-0.30	"
4th week of Nov. 1985	27.47	10.71	91.85	-	9-10	Mostly Partial
1st week of Dec. 1985	26.42	10.14	96.57	-	9-10.30	"
2nd week of Dec. 1985	25.85	9.57	95.85	-	8-10	"
3rd week of Dec. 1985	24.71	11.14	97.00	-	9-10.30	"
4th week of Dec. 1985	22.42	9.57	98.57	11.25	9-11	"
1st week of Jan. 1986	18.85	9.28	100.00	-	9-10.30	"
2nd week of Jan. 1986	24.62	8.00	99.12	-	10-10-30	Mostly Clear
3rd week of Jan. 1986	24.85	7.00	98.00	-	8-11	"
4th week of Jan. 1986	25.28	7.71	94.14	-	7-11.30	Mostly Partial
1st week of Feb. 1986	24.85	9.28	97.00	-	8-12	"
2nd week of Feb. 1986	25.75	9.75	90.50	2.13	7-10	"
3rd week of Feb. 1986	25.14	9.57	87.85	1.14	-	Mostly Clear
4th week of Feb. 1986	28.42	10.00	87.28	-	-	Clear
1st week of March 1986	29.42	10.14	75.71	-	-	Mostly Partial
2nd week of March 1986	32.00	13.57	72.71	-	-	"
3rd week of March 1986	32.71	13.28	54.85	-	-	Mostly Clear
4th week of March 1986	34.71	13.14	50.42	-	-	"
1st week of April 1986	37.28	15.71	42.71	0.14	-	"
2nd week of April 1986	34.83	15.14	66.66	6.76	-	"

Annex - 2/2

Meteriological Data (Weekly Average)

1988/89

Date	Temperature Max. °C	Min. °C	Rainfall (mm) (mm)	Relative Humidity (%)	Dewamount (%)
17-23 Sept. 1988	32.78	24.89	1.87	85	-
24-30 Sept.	35.00	24.77	0.00	81	-
1-7 Oct.	33.74	21.82	6.17	84	-
8-14 Oct	33.84	20.04	0.00	83	-
15-21 Oct.	33.40	19.04	0.00	79	0.1
22-28 Oct.	32.50	17.22	0.00	84	0.1
29-4 Nov.	31.87	14.12	1.50	79	0.1
5-11 Nov.	30.14	11.47	3.30	90	0.1
12-18 Nov.	30.35	11.00	0.00	97	0.1
19-25 Nov.	30.71	11.28	0.00	91	0.1
26-2 Dec.	29.00	9.42	0.00	91	0.1
3-8 Dec.	27.75	11.11	0.00	94	0.1
9-15 Dec.	26.00	11.00	0.00	98	0.15
16-22 Dec.	25.57	11.57	0.00	97	0.12
23-29 Dec.	22.57	10.57	16.10	98	0.1
30-5 Jan. 1989	24.00	8.87	0.20	97	0.26
6-12 Jan.	19.00	7.37	24.75	99	0.23
13-19 Jan.	22.01	4.91	0.00	100	0.18
20-26 Jan.	23.30	8.31	0.00	100	0.17
27-2 Feb.	24.22	8.00	0.00	100	0.13
3-8 Feb.	25.85	9.50	0.00	85	0.06
9-15 Feb.	24.50	8.66	0.02	84	-
16-22 Feb.	23.08	6.24	0.15	83	-
23-1 March	30.98	8.81	0.00	79	-
2-8 March	30.48	11.81	0.00	77	-
9-15 March	30.98	13.31	0.01	74	-
16-22 March	31.50	14.21	0.00	66	-
23-29 March	32.85	15.00	0.00	61	-
30-5 April	32.28	14.14	3.47	63	-