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Effect of planting method and nitrogen on potato (*Solanum tuberosum*) production under drip irrigation

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ABSTRACT

A field experiment was conducted on light-textured soil (Typic Ustocrept) during 1991–92 and 1992–93, to evaluate the effect of planting methods and nitrogen levels on growth characters and tuber yield of potato (*Solanum tuberosum* L.) under drip irrigation. Flat-planting methods improved emergence-rate index, plant height and stem density. Potato tuber yield was 47.5, 22.0 and 26.8% higher under the treatments consisting of flat planting at 30 cm x 20 cm, 60 cm x 20 cm and single ridge planting as compared with double-row-ridge planting method, respectively. Potato response to N application at 60, 120 and 180 kg N/ha was 77, 127 and 150 q/ha respectively.

Drip irrigation is a recently developed efficient technique of irrigation. The method supplies the requisite soil moisture to raise a crop successfully even in sandy soils and under water-scarse conditions. In potato (*Solanum tuberosum* L.) it results in higher water-use efficiency due to increased available moisture and reduced water losses. As a result there was 20% more yield over furrow method of irrigation (Gupta and Singh, 1983; Singh and Sood, 1993). In addition, irrigation also improves nitrogen-use efficiency in furrow method of irrigation (Singh and Grewal, 1983). However such information with drip irrigation is lacking. The present study was therefore undertaken to evaluate the effect of planting methods and nitrogen levels in potato under drip irrigation.

MATERIALS AND METHODS

A field experiment was laid out on light-textured soils (Typic Ustocrept) at Central Potato Research Station, Modipuram, during 1991–92 and 1992–93. The soil of experimental field was low in organic matter (0.28%) and available N (94 ppm), medium in available potassium (71 ppm) and high in available phosphorus (13 ppm). The treatments included 4 planting methods, i.e. single row-ridge planting at 60 cm x 20 cm spacing (M_1), double row-ridge planting (M_2), flat planting at 60 cm x 20 cm spacing (M_3) and flat planting at 30 cm x 20 cm spacing (M_4) having 83,333; 83,333; 83,333 and 166,666 plants/ha respectively in main plot; and 4 levels of nitrogen, i.e. 0, 60, 120 and 180 kg N/ha, in subplots replicated 4 times in split-plot design. In single row-ridge planting, the traditional method was followed, while in double row-ridge planting, the ridge and furrow width were 60 cm each and 2 rows of potato were raised on each ridge with 20 cm x 20 cm spacing. In flat

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planting, no ridging was done. Thus unlike M_1, M_3, M_4 in M_2 method, 2 rows of potato were irrigated by single-drip pipe-line. Half dose of nitrogen through calcium ammonium nitrate and full dose of P_2O_5 and K_2O were applied at the time of planting. The remaining half dose of nitrogen through urea was top-dressed 4 weeks after planting. Potato crop was planted in 1991–92 after green-manuring and in 1992–93 without green-manuring. Irrigations were scheduled and given on the basis of cumulative pan evaporation at alternate day. One post-planting irrigation was given to the crop through furrow and ridge method of irrigation for uniform emergence. Whole seed tubers of 40 g (± 5 g) size of cv. 'Kufri Bahar' were planted as per treatments in the third week of October and crop was harvested at full maturity. Water (195 mm) was applied to raise the crop.

RESULTS AND DISCUSSION

Flat planting at 30 cm x 20 cm spacing gave the highest tuber yield during 1991–92 and 1992–93 respectively (Table 1). This may be attributed to higher plant density (166,666 plants/ha) and more water supply due to reduced distance between 2 drip pipelines (30 cm.) But the double row-ridge planting method was inferior during both the years. This could be due to lack of sufficient soil moisture to meet the crop requirement, since 2 rows of potato were irrigated by single drip pipe-line. The yield from different planting methods were in the order of $M_4 > M_1 > M_3 > M_2$. Similar trend was also observed in case of medium-size tubers, and the differences could be attributed due to variation in plant density, emergence rate in-

Table 1. Potato yield as influenced by planting methods and nitrogen

Treatment	Seed rate (q/ha)	Total yield (q/ha)			Net yield (total yield-seed used) (q/ha)		
		1991–92	1992–93	Mean	1991–92	1992–93	Mean
Methods of planting							
Single row ridge planting at 60 cm x 20 cm spacing	33.3	242	212	227	209	179	194
Double row-ridge planting at 100 cm distance (20 cm x 20 cm spacing)	33.3	195	164	179	161	131	146
Flat planting at 60 cm x 20 cm spacing	33.3	233	206	219	200	173	186
Flat planting at 30 cm x 20 cm spacing	66.6	281	248	264	215	182	198
CD (P = 0.05)		28	26		23	27	
N (kg N/ha)							
0		157	111	134	115	69	92
60		228	194	211	186	153	169
120		280	242	261	238	200	219
180		285	284	284	243	242	242
CD (P = 0.05)		13	10		9	11	

Table 2. Emergence-rate index and plant-growth characters as influenced by planting methods and nitrogen

Treatment	Emergence-rate index			Plant height (cm)			Stems/plant		
	1991–92	1992–93	Mean	1991–92	1992–93	Mean	1991–92	1992–93	Mean
Methods of planting									
Single row-ridge planting at 60 cm x 20 cm spacing	0.86	0.82	0.84	32.1	36.5	34.3	5.3	4.2	4.7
Double row-ridge planting at 100 cm distance (20 cm x 20 cm spacing)	0.77	0.72	0.74	30.2	35.7	32.9	5.1	4.1	4.6
Flat planting at 60 cm x 20 cm spacing	0.86	0.83	0.84	30.7	37.6	34.1	5.0	4.2	4.6
Flat planting 30 cm x 20 cm spacing	0.91	0.90	0.90	32.1	38.2	35.1	5.0	4.2	4.6
CD (P = 0.05)	0.04	0.01		1.6	2.3		NS	NS	
N (kg N/ha)									
0	0.83	0.80	0.81	22.8	27.7	25.2	4.6	3.5	4.1
60	0.86	0.83	0.84	32.6	36.6	34.6	5.1	4.2	4.6
120	0.85	0.82	0.83	33.9	41.3	37.6	5.3	4.4	4.8
180	0.86	0.82	0.84	35.3	42.4	39.1	5.4	4.5	4.9
CD (P = 0.05)	0.01	0.01		1.5	1.6		NS	0.2	

NS, Non significant

dex and other growth characters (Table 2).

The response to nitrogen was not same in both the years. In 1991–92 and 1992–93, tuber yield increased significantly up to 120 and 180 kg N/ha respectively. The plant height and number of stems/plant were favourably influenced by nitrogen levels (Table 2). In 1991–92 N up to 120 kg/ha showed significant increase in aggregate and medium-size tubers (Tables 1, 3). The practice of green-manuring before potato crop is thus beneficial particularly in light soils with low organic matter content. (Grewal, 1974; Grewal *et al.* 1981).

In 1992–93, tuber yield was increased with increase in nitrogen levels up to 180 kg/ha, the highest level was tried (Table 1). The increase was 83, 131 and 173 q/ha with 60, 120, 180 kg N/ha respectively. Thus tuber-yield response increased with an increase in N level. This could be due to difference in maturity period of the crop. The plots receiving higher doses of N remained green for a longer period compared with low nitrogen and the control plots. Thus the N application extended the functional life of the potato foliage, which helped in tuber development. The response/kg N, however, decreased with increased nitrogen doses. It was 128, 106 and 83 kg tuber at 60, 120 and 180 kg N/ha respectively. The high potato response to N application could be due to low available N and low organic matter in the soil. Plant height and stems/plant were also favourably influenced by application (Table 2). Singh and Grewal (1983) also reported

Table 3. Tuber (grade-wise) yields as influenced by planting methods and nitrogen

Treatment	Grade-wise tuber yields (q/ha)								
	Large (> 75 g)			Medium (25–75 g)			Small (< 25 g)		
	1991–92	1992–93	Mean	1991–92	1992–93	Mean	1991–92	1992–93	Mean
Method of planting									
Single row ridge planting at 60 cm x 20 cm spacing	31	58	44	192	137	164	19	16	18
Double row-ridge planting at 100 cm distance (20 cm x 20 cm spacing)	20	40	30	152	104	128	23	20	21
Flat planting at 60 x 20 cm spacing	31	51	41	183	137	160	19	18	18
Flat planting 30 cm x 20 cm spacing	30	52	41	223	161	192	28	34	31
CD (P = 0.05)	7	NS		22	16		4	8	
N (kg N/ha)									
0	10	13	11	122	74	98	24	23	23
60	19	41	30	187	133	160	22	21	21
120	34	64	49	224	156	190	23	22	22
180	47	84	65	217	177	197	20	22	21
CD (P = 0.05)	5	8		27	16		3	NS	

that the per unit N response decreased with increasing N levels. Similar trend was also noticed in large-size tubers, while the medium-size tubers responded significantly only up to 120 kg N/ha.

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