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lengths as well as under natural (control) daylength. All plants, except those grown under the control daylength, received ten hours of sunlight per day (from 07 h 00 to 17 h 00). For the remaining time, light of 200 - 220 lux intensity, sufficient only to cause a photoperiodic effect was provided by fluorescent tubes. The intensity of artificial light was assumed to have a negligible effect on photosynthesis. Natural daylength during the growing period averaged about 17 hours. A split-plot design was used with the daylength treatments assigned to main plots and stem numbers to subplots.

Ten-liter plastic pots filled with a growth medium composed of compost, fine sand and peat in the ratio of 4.5:4.0:0.2 kg, respectively, on a dry weight basis were used to grow the plants. Based on previous experience five grams of 'nitrophosca' fertilizer (6:10:18:2 = N:P:K:Mg) and 15 ml of boric acid per pot were mixed before planting. The daylength treatments were begun with the appearance of the first pair of leaves and were continued up to complete senescence.

Harvesting was made 44 days after emergence (DAE) and after complete senescence in each year. There were six and ten replications for the first and second harvests, respectively. At first harvest the plants were separated into leaves, stems, stolons and tubers, and their fresh weights were immediately determined. The dry weight of each plant part was measured after the samples were dried for at least 24 hours at 105°C. Data on number of tubers, average tuber weight and tuber yield were recorded for both harvests. Only those tubers which were greater than 10 mm in diameter were considered. Average tuber weight was calculated by dividing the total weight of tubers greater than 10 mm in diameter by their total number. Tuber crude protein content was determined using the Kjeldahl method. Percentage values were transformed using the arc sine transformation before statistical analysis.

RESULTS AND DISCUSSION

Plants grown under the shortest daylength (12-hours) had a significantly smaller leaf area than those under the other daylengths considered (Table 1). This is attributed to the fact that short days promote the onset of tuber initiation at the expense of leaf development as reported by several authors including Steward et al. (1981). Leaf area increased consistently and often significantly with increasing number of stems per plant. Table 1 also shows that the effect of daylength on the number of tubers produced varied with the stage of plant growth and year. In 1983 at 44 DAE, fewer tubers were produced under the longest (20-hours) daylength than under the shortest or under the natural daylength. In contrast, in 1984 the number of tubers produced at 44 DAE was smallest under the shortest daylength. The difference in tuber number between

the two years is expected to be temperature differences. The year 1984 was cooler than 1983. It was reported that at lower temperatures the onset of tuber initiation is faster than at higher temperatures (Menzel 1983) and low temperatures modify the delaying effects of long days on tuber initiation. Thus in 1984 plants grown even under the longer daylengths (16 and 20-hours) might have started tuber initiation early during growth and completed before 44 DAE, as the number of tubers obtained after senescence was less than that at 44 DAE. The reduction in tuber number can be attributed to the process of resorption (Cho and Iritani 1983).

Plants grown under the natural daylength produced the highest number of tubers. This was ought to be due to the direct effect of the amount of radiation intercepted by these plants, which determines tuber initiation (Caesar et al. 1981) and the larger number of tubers that continue to grow (Sale 1973).

In both years and for all harvests, tuber number increased with increasing number of stems per plant (Table 1). This may be due to the bigger leaf areas of multi-stem plants at the time of tuber initiation and a better spatial arrangement of leaves on multi-stems than on one or two stems which increased light interception by decreasing mutual shading of leaves. Table 2 shows that, average tuber weight at 44 DAE was highest under the shortest daylength and varied significantly ($P < 0.01$) from those obtained under the remaining daylengths. The effect of daylength on average tuber weight after senescence was less than that at 44 DAE. Those daylengths which resulted in the production of larger number of tubers reduced average tuber weights. Variations in the number of stems per plant did not affect average tuber weight at 44 DAE. This was because of the larger number of tubers produced by multi-stem plants. Berga Lemaga and Caesar (1990) reported that there is a negative relationship between tuber number and average tuber weight.

At 44 DAE the shortest and the natural daylengths resulted in significantly higher tuber yields than a daylength of either 16 or 20 hours. Tuber yield per plant under the former two daylengths was above 200 g, while under the latter two it remained below 140 g (Table 3). The higher tuber yield under the former two daylengths is attributed to the earlier onset of tuber initiation and to the distribution of more of the dry matter to tubers (Fig. 2) than that occurred under the latter two daylengths. The promotion of both the onset of tuber initiation and the distribution of dry matter to tubers by the natural daylength can be explained by the fact that a high amount of intercepted radiation has a potential to override the effect of long days (Wheeler and Tibbitts 1986). The plants under the natural daylength intercepted more photosynthetically active radiation than those grown under the other daylengths considered in this study.

After senescence, because of the small leaf area and the short growing period, tuber yield was lowest under the shortest daylength (Table 3). This

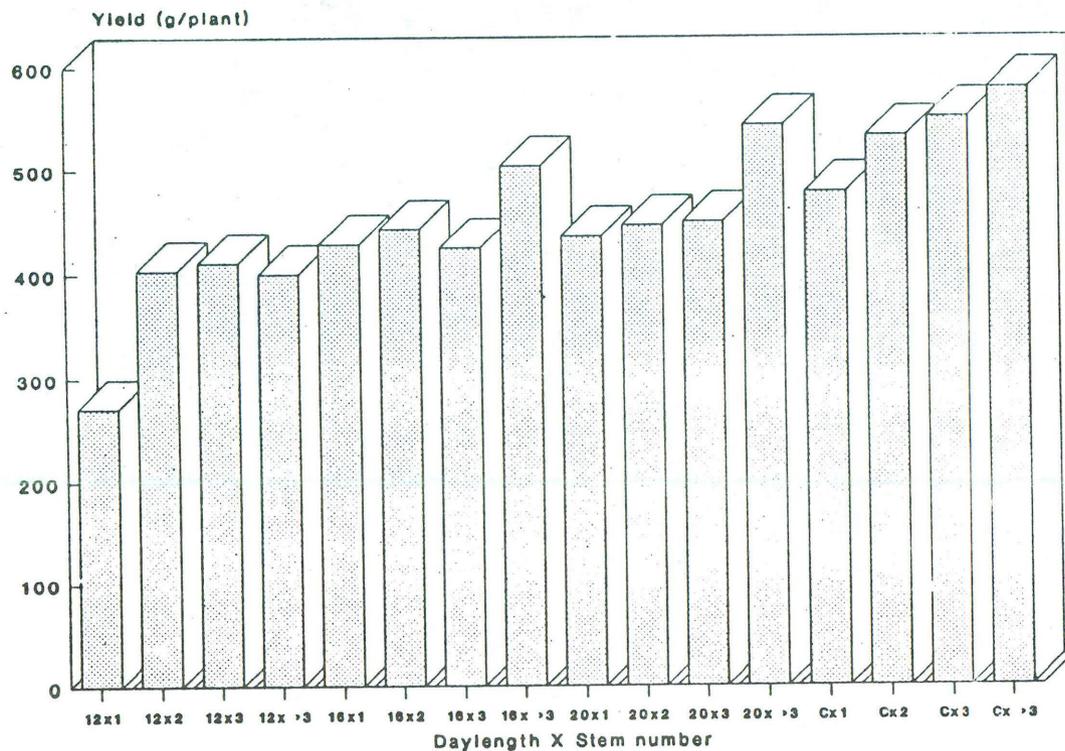


Fig 1. Daylength and stem number interactions on fresh tuber yield after senescence

Table 3. Effects of daylength and stem number on tuber yield per plant (main effects)

Daylength	Tuber yield (plant ⁻¹)			
	1983		1984	
	44 DAE	Sene.	44 DAE	Sene.
12 hr	250.2	371.6	210.5	352.1
16 hr	135.3	450.2	115.4	414.8
20 hr	115.1	468.9	100.7	384.0
Natural	215.6	534.2	210.6	474.1
LSD (0.05)	45.5	43.4	25.4	39.5
LSD (0.01)	60.7	58.2	45.0	53.0
No. of stems/plant				
1	120.8	408.6	110.7	340.2
2	175.3	453.6	135.6	370.7
3	185.5	457.1	195.4	430.3
>3	255.2	505.6	240.2	483.8
LSD (0.05)	30.4	23.4	25.5	33.5
LSD (0.01)	40.3	31.0	40.3	44.4

DAE = days after emergence; Sene = Senescence

The distribution of dry matter to the different parts of plant was significantly affected by daylength and stem number. These results refer to those obtained at 44 DAE. The shortest daylength significantly promoted dry matter partitioning to tubers when compared with the other daylengths (Fig. 2). The corresponding values in the 1984 were 62%, 37%, 35%, and 45% under the 12, 16, 20-hour and natural daylengths, respectively. These figures, however, may change with the advancement of plant growth as the higher number of tubers produced under the longer daylengths act as active sink organs resulting in a higher dry matter accumulation in the tubers. Next to tubers, a higher percentage of dry matter was accumulated in leaves followed by stems.

A small amount of the dry matter was partitioned to stolons and roots (data not shown for roots) in 1984, especially under the shortest daylength. With increasing number of stems per plant, there was a significant increase in the DM distributed to tubers. The opposite, however, held true for dry matter distribution in the acropetal direction, i.e., to leaves and stems (Fig. 3). A shortened daylength and an increased number of stems per plant affected similarly the distribution of dry matter to the different parts of the potato plant. In contrast to tuber yield, the crude protein content of tubers at final harvest was significantly higher ($P < 0.01$) under the shortest daylength (Table 5). This is in agreement with the findings of Steward et al. (1981). According to Pavia et al. (1983), the rate of accumulation of patatin, a major tuber protein, is much faster in shorter than in longer daylengths. But since tuber yields are higher in the temperate zone due mainly to long days, total protein yield may also be higher. Differences in both tuber and protein yields can be narrowed by adapting more plants in the tropics and subtropics, where leaf development is limited due to the earlier onset of tuber initiation. Variation in stem number per plant did not affect tuber crude protein content but the total crude protein yield was higher with increasing stem number. This was because of a higher tuber yield at increased stem densities.

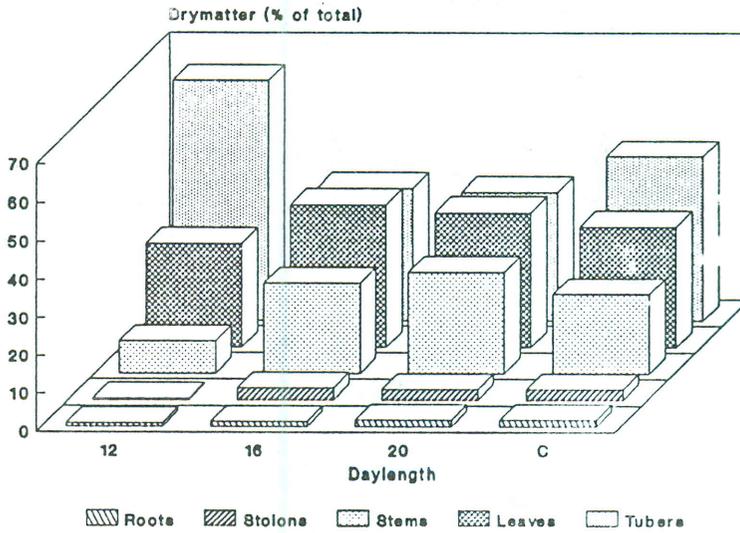


Fig. 2. Effects of daylength on distribution of drymatter to different parts of a potato plant

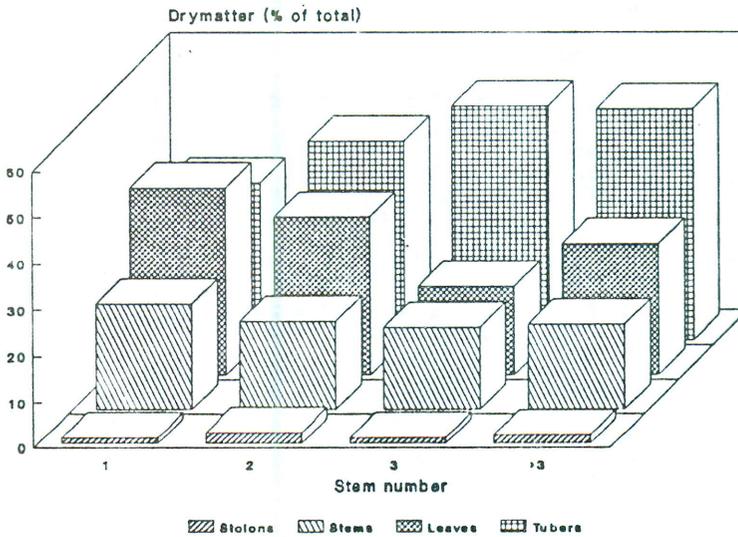


Fig. 3. Effects of stem number on distribution of dry matter to different parts of a potato plant

Table 4. Effects of daylength and stem number on tuber number and yield per stem (main stem effects)

Daylength	No. of tubers per stem				Tuber yield (g stem ⁻¹)			
	1983		1984		1983		1984	
	44DAE	Sene.	44DAE	Sene.	44DAE	Sene.	44DAE	Sene.
12 hr	7.0	6.5	6.2	6.2	112.9	171.9	94.0	165.4
16 hr	6.6	7.7	7.5	7.5	48.2	218.1	47.9	184.9
20 hr	5.6	7.6	7.9	7.1	39.9	224.0	50.1	182.6
Natural	10.5	9.6	11.1	10.2	110.7	255.2	92.4	225.5
LSD(0.05)	1.4	1.5	1.7	1.1	25.2	23.6	18.5	26.1
LSD(0.01)	1.9	2.0	2.3	1.5	34.4	31.7	25.2	37.4
No of stems per plant								
1	11.9	14.0	12.0	11.4	120.1	408.6	107.8	340.2
2	8.5	8.0	7.8	7.9	88.5	226.8	67.3	185.4
3	6.0	6.3	7.8	7.2	62.2	152.4	65.1	143.4
>3	3.5	3.4	5.0	4.6	40.9	81.1	44.2	89.4
LSD(0.05)	1.5	1.0	1.5	1.0	18.8	15.7	15.9	22.9
LSD(0.01)	2.0	1.4	2.0	1.3	25.0	20.8	21.1	30.4

DAE = days after emergence; Sene. = senescence

Table 5. Effects of daylength and stem number on tuber crude protein content and yield after senescence (main effects)

Daylength	Protein content (% DM)		Protein yield (g plant ⁻¹)	
	44 DAE	Sene.	44 DAE	Sene.
12 hr	12.04	9.65	8.95	6.80
16 hr	9.67	8.02	8.70	6.65
20 hr	9.87	8.46	9.26	6.50
Natural	8.00	7.67	8.54	7.27
LSD (0.05)	0.44	0.63	NA	NA
LSD (0.01)	0.59	1.01	—	—
No. of stems/plant				
1	9.87	8.43	8.07	6.31
2	9.93	8.31	9.01	6.16
3	9.98	8.56	9.12	7.37
>3	9.81	8.50	9.92	8.22
LSD (0.05)	NS	NS	NA	NA

DM = dry matter; DAE = Days after emergence
 NA = not analyzed statistically; NS = not significant

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