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Effect of maturity on nitrogen fractions in potato

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Summary

Different parts of plants of three potato cultivars were analysed 31, 47, 63, 79, 95 and 111 days after plant emergence to determine the variations in nitrogen fractions between cultivars and during growth to maturity. In all cultivars protein nitrogen in different parts decreased upto the 79th day and thereafter it remained constant. The organic nitrogen fraction of non-protein nitrogen followed a similar pattern except that it increased in the tuber during the last stages of maturity.

Introduction

The level of soil fertility (Hoff et al., 1971), growing temperature (Vigue, 1973) and genotype (Desborough & Weiser, 1972) affect the protein and non-protein nitrogen (NPN) contents of potato tubers. The NPN fraction of tubers comprises about 40–70 % of total nitrogen (Kapoor et al., 1975; Li & Sayre, 1975), but a large quantity of NPN is leached out during processing. Most studies have been conducted on mature potato tubers and little work has been done to study protein metabolism during growth of the potato plant. Knowledge of protein synthesis relative to different nitrogen fractions in the developing plant, particularly in tubers of different cultivars, may be useful in determining the agronomic and genetic factors affecting protein composition in these storage organs at maturity.

The work described in this paper was undertaken to investigate the changes which occur in various nitrogen fractions during the development of potato plants.

Materials and methods

Three cultivars, Kennebec, Norchip and Early Ohio, were grown in a loam:peat:sand mixture (2:1:1) in 20 cm diameter pots in a growth chamber. A regime of 22/19 °C, day-night temperature with 16 hours light was held for the first 35 days and 20/17 °C with 14 hours light during the remaining period. A mixed fertilizer (20:20:20) equivalent to 140 kg/ha was applied at the time of planting and none thereafter. Samples were collected at 31, 47, 63, 79, 95 and 111 days after emergence. The root systems were washed with distilled water and the plants separated into roots, stems, leaves and tubers. After determination of fresh weight, samples were freeze-dried and ground through an 80-mesh sieve for further analysis.

Table 1. Protein nitrogen, inorganic and organic nitrogen in non-protein nitrogen fractions of different parts of potato plants during growth and development (mg/100 g dry weight).

Cultivar and plant part	Protein nitrogen						Non-protein nitrogen											
							inorganic nitrogen						organic nitrogen					
Days after emergence →	31	47	63	79	95	111	31	47	63	79	95	111	31	47	63	79	95	111
Kennebec																		
Leaf	4000	3200	3030	2320	2350	2380	176	140	80	65	50	45	1344	560	250	235	230	215
Stem	1820	1200	1110	950	820	770	265	220	90	55	25	30	995	540	190	125	115	110
Root	2390	1740	1510	1290	1510	1280	210	260	50	90	40	50	620	360	190	150	182	110
Tuber	–	–	1140	1040	950	720	–	–	90	80	20	20	–	–	440	420	380	590
Norchip																		
Leaf	4001	3810	3190	2790	2460	2540	242	140	60	55	55	65	1568	780	290	205	145	195
Stem	1970	1060	1100	930	830	700	307	280	150	65	40	35	1113	496	150	160	70	75
Root	2160	1740	1177	1860	1810	1900	265	260	50	40	50	63	575	420	210	145	340	237
Tuber	–	–	1260	1090	1000	900	–	–	80	90	20	20		–	420	320	390	580
Early Ohio																		
Leaf	3210	3100	3050	2500	2230	2130	153	130	80	65	45	70	1217	440	260	255	210	220
Stem	1790	1000	860	610	720	700	268	260	100	55	40	55	632	260	140	95	50	55
Root	2190	1760	1690	1470	1410	1310	240	220	50	50	40	52	570	430	200	390	310	188
Tuber	–	–	1010	950	790	650	–	–	60	70	20	20		–	410	370	420	530

Non-protein nitrogen (NPN) was extracted from samples with 80 % ethanol (Kapoor et al., 1975). Inorganic and organic nitrogen contents of NPN fractions were separated by activated Dowex-4 (H^+) cation exchange resin packed in a glass column (8 cm × 1 cm). The samples of NPN were passed through column which retained organic nitrogen which was then eluted with 4 *N* HCl and collected for further analysis. Nitrogen in the ethanol extract, residue (obtained after extraction) and organic NPN was estimated by micro-Kjeldahl (Horowitz, 1970). Inorganic nitrogen was calculated by differences (Total NPN - organic NPN).

Results and discussion

Protein nitrogen was highest in the leaf tissue followed by that in the root in all the stages of development, whereas the stem contained the lowest amount (Table 1). This fraction decreased in different parts up to 79 days and thereafter there was generally little change. Organic and inorganic nitrogen fractions of NPN followed a similar pattern except that the organic nitrogen fraction increased in tubers at the last sampling stages. This increase may be related to senescence and could be caused by mobilization of NPN from haulms to tubers (Synder et al., 1977). No marked varietal difference was observed in these nitrogen fractions. The data showed that protein nitrogen constituted 60–80 % of the total nitrogen in different parts of potato plants, the percentage increasing with maturity. Organic nitrogen in NPN was a major fraction and inorganic nitrogen was present in only small amounts. The main component of inorganic nitrogen could be nitrate as ammonia is usually present only in negligible quantities.

These results are in agreement with those of Kapoor & Gupta (1976) who also reported that nitrogen in vegetative parts of soybean plant decreased as the plant matured and that NPN constituted a small portion of total nitrogen.

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