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Effect of Interaction of K and Na on Nutrient Partitioning in Chinese Potato (*Plectranthus rotundifolius*)

Chinese potato (*Plectranthus rotundifolius*) is a minor tuber crop grown in tropical Asia, for its edible tubers, which have special flavour and taste and used as vegetable. Tuber crops, in general, have a high requirement for K. Sodium, though not considered as essential for higher plants, is reported to exert beneficial effects on the growth and yield of many plants when used in combination with K, especially when K availability in the growth medium is low (Sudharmaidevi and Padmaja, 1999; Idowu and Aduayi, 2007). Based on these findings, an investigation was carried out to evaluate the effect of K: Na interaction on the growth performance of Chinese potato. A synergistic effect of K: Na interaction on tuber yield was reported earlier (Neenu and Sudharmaidevi, 2008). The present paper discusses the interaction effect of applied K and Na on the distribution of major and secondary nutrients in the different plant parts of Chinese potato.

A field investigation was carried out at College of Agriculture (Kerala Agricultural University) Thiruvananthapuram (8°30′E latitude, 29 m above MSL) for studying the effect of application of different doses of K and Na on the performance of Chinese potato. The experiment was conducted in Randomized Block Design with seven treatments and three replications. Sree Dhara, a high yielding variety of Chinese potato, was used for the study. Different combinations of K @ 50 and 100 kg ha^{-1} and Na @ 50, 75 and 100 kg ha^{-1} were tested against the control (full recommended dose of K i.e., 100 kg ha^{-1}). Potassium was supplied as muriate of potash (50% K) and Na as common salt (39.3% Na). Cattle manure, N and P_2O_5 were applied uniformly in all plots @ 10 t ha^{-1}, 60 kg ha^{-1} and 60 kg ha^{-1} respectively. The soil of the experimental site (Rhodic Haplustult) was acidic in reaction (pH 5.6) with an electrical conductivity of 0.01 dS m^{-1}. Texture of the soil was sandy loam with medium status of available N (301 kg ha^{-1}) and K (142 kg ha^{-1}) and high status of available P (89 kg ha^{-1}). Harvesting was done five months after planting. After harvest of the plant, the leaves, stems, tubers and roots were separately analyzed for the nutrient concentration. Nitrogen was estimated by modified Kjeldahl method after digestion with concentrated sulphuric acid. Determination of P, K, Na, Ca and Mg were done after digestion with nitric-perchloric acid mixture in the ratio 9:4 (Piper, 1966). Estimation of P was done by the vanado molybdic yellow colour method using a spectrophotometer (Systronics Model 169), K and Na using a flame photometer (Elico Model CL 22 D) and Ca and Mg by the versenate method. Statistical analysis of the data was done to find out the relationship between variables and to draw definite conclusions.

Marked changes in nutrient concentrations in different plant parts were observed as a result of K: Na interaction. It is interesting to note that the same pattern was obtained for the distribution of nutrients in the aerial as well as below ground

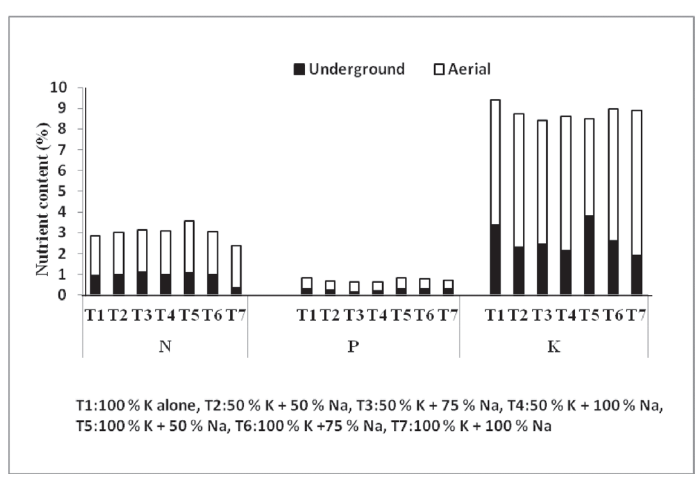

Fig 1. Effect of K: Na interaction on the distribution of N, P and K in the aerial and underground parts of Chinese potato

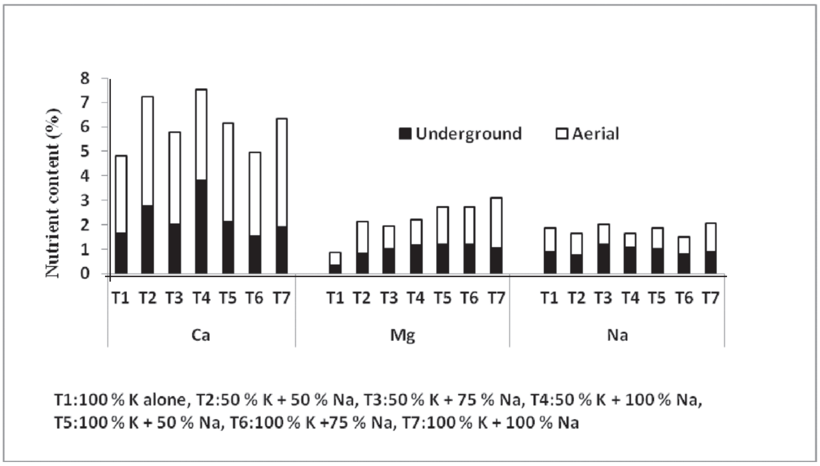

Fig 2. Effect of K: Na interaction on the distribution of Ca, Mg and Na in the aerial and underground parts of Chinese potato

plant parts (Fig.1 and Fig. 2). The pattern of accumulation of N clearly showed that it was preferentially accumulated in leaves. In all the treatments, about one-third of N absorbed was present in the leaves and only a small portion was stored in the stem (Table 1). This is expected since leaf is the photosynthetic organ and N is a mobile nutrient, the plant will always supply more N to the leaves. The leaf N concentration has the strongest effect on chlorophyll synthesis (Olfs et al., 2005) and thereby on yield. The relationship between leaf N and yield in the present study confirms this relationship (Table 1). The N content in leaf and root did not vary significantly among the treatments, but stem and tuber N varied significantly as a result of treatments. When 50% Na was applied along with 50 or 100% K, an increase in total N concentration was observed. Smith et al. (1980) reported that in rye grass and timothy plant, the concentration of total and nitrate N increased in all tissues as a result of increased applications of sodium chloride.

Contrary to this, the distribution of P was found to be the highest in below ground parts compared to aerial parts (Table 1). Significant difference could not be observed among the treatments for the content of P in different plant parts, except in roots. In stem, tuber and root, the concentration of P was lower in all the treatments that received 50% K along with different levels of Na. Ullah et al. (1994) reported that phosphate concentration declined with increasing salt concentration in tomato plants and this may be due to the presence of chloride present in the solution which depressed the P uptake. Since there was no significant difference among the treatments in the content of foliar P, it can be assumed that all the treatments were equally efficient in utilizing the applied P. The distribution pattern of K clearly showed that a major portion of K was accumulated in stem followed by roots (Table 1). Leaf and tuber K contents varied significantly due to the treatments. The highest leaf K content was found in plants that received 75 and 100% Na along with 100% K. In all the treatments the lowest K content was found in leaves. This shows that

Table 1. Distribution of N, P and K (%) in the different plant parts of Chinese potato and tuber yield as influenced by K: Na interaction

Treatments	Leaf			Stem			Tuber			Root			Yield
	N	P	K	N	P	K	N	P	K	N	P	K	(t ha^{-1})
100% K alone	1.36	0.32	1.52	0.56	0.20	4.51	0.99	0.31	2.03	0.94	0.32	3.38	24.0
50% K + 50% Na	1.29	0.24	1.79	0.73	0.18	4.64	0.94	0.25	1.72	1.00	0.23	2.29	30.6
50% K + 75% Na	1.38	0.25	1.85	0.65	0.22	4.11	0.69	0.26	1.93	1.09	0.14	2.45	30.0
50% K + 100% Na	1.41	0.26	1.51	0.68	0.19	4.95	0.64	0.36	2.43	0.98	0.18	2.15	29.3
100% K + 50% Na	1.57	0.29	1.69	0.92	0.23	3.01	1.42	0.33	2.04	1.08	0.31	3.79	25.3
100% K +75% Na	1.29	0.27	2.15	0.77	0.23	4.17	0.94	0.30	1.84	0.99	0.30	2.63	21.9
100% K + 100% Na	1.13	0.22	1.88	0.93	0.19	5.09	0.74	0.32	1.88	0.33	0.31	1.90	25.3
CD (0.05)	NS	NS	0.64	0.29	NS	NS	0.38	NS	0.49	NS	0.09	NS	6.25

Table 2. Effect of application of K and Na on the distribution of Ca, Mg and Na (%) in the various plant parts of Chinese potato

Treatments	Leaf			Stem			Tuber			Root		
	Ca	Mg	Na	Ca	Mg	Na	Ca	Mg	Na	Ca	Mg	Na
100% K alone	2.86	0.27	0.53	0.27	0.27	0.45	0.21	0.16	0.33	1.44	0.16	0.56
50% K + 50% Na	3.48	0.32	0.32	1.01	1.01	0.59	0.37	0.37	0.36	2.37	0.43	0.37
50% K + 75% Na	3.25	0.43	0.41	0.51	0.51	0.40	0.32	0.32	0.41	1.68	0.69	0.77
50% K + 100% Na	3.09	0.43	0.20	0.61	0.61	0.37	0.44	0.51	0.32	3.37	0.64	0.75
100% K + 50% Na	3.20	0.69	0.40	0.85	0.85	0.44	0.45	0.53	0.40	1.65	0.64	0.61
100% K +75% Na	2.51	0.61	0.25	0.91	0.91	0.49	0.41	0.45	0.36	1.12	0.75	0.40
100% K + 100% Na	2.83	0.45	0.53	1.60	1.60	0.61	0.40	0.43	0.33	1.49	0.59	0.56
CD (0.05)	0.66	0.20	0.32	0.15	0.15	NS	0.17	0.13	0.36	0.98	0.18	NS

the major quantity of K taken up was not utilized fully, but stored in the stem. Marschner (1995) reported that when K^+ supply is abundant, "luxury consumption" often occurs, which affects plant composition and interferes with the uptake and physiological availability of other nutrients especially Ca^{2+} and Mg^{2+}. But as against this, Na was found highest in roots, followed by stem (Table 2). Vigo et al. (2005) reported that the plants retained Na^+ and Cl^- ions in the basal part of stems and roots. The lowest content was seen in leaves except in the treatments 100% K alone and 100% K: 100% Na. The extent to which Na is taken up by plants is influenced by other nutrients, particularly K and N (Reith et al., 1964).

The pattern of distribution of Ca and Mg suggests that they are easily translocated to the above ground portions. A major portion of Ca in all the treatments was found to be transported to the leaves (Table 2). Ullah et al. (1994) reported that Ca concentration in tomato plants was not affected by salt stress. Under limited K supply, Na, Mg and Ca can replace K in the vacuole as an alternative inorganic osmoticum (Flowers and Lauchli, 1983). In the case of Mg, the highest quantity was seen in stem, followed by roots (Table 2). Vigo et al. (2005) reported that Mg concentration increased in stems and roots with increasing salinity. Ullah et al. (1994) also reported that a positive relation existed between Mg and salt concentration. That means Na may increase the absorption of Mg and in the presence of Na, plants may not suffer from Mg deficiency even in soils low in Mg. From this study it can be concluded that application of Na and K in 50:50 combination can improve the absorption of Ca and Mg and thereby tuber yield in Chinese potato. Also, it was observed that the distribution of nutrients followed a similar pattern in the aerial as well as the below ground parts of the plant.

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