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Uptake of N, P, K, Tuber Yield and Quality of Chinese Potato (*Plectranthus rotundifolius*) as Influenced by Date of Planting and Nutrient Management

A field experiment was conducted at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala from November 2013 to May 2014 to fix the best time of planting Chinese potato (*Plectranthus rotundifolius*) and nutrient management for maximum yield under Thiruvananthapuram condition for off season production of Chinese potato adopting the photo-insensitive variety Suphala. The experiment was laid out in split plot design with four dates of planting starting from November 15 at fortnightly intervals in main plots and three nutrient management practices (recommended dose through fertilizers and through organic manures and modified nutrient dose through fertilizers) in sub plots with four replications. The results revealed that uptake of N, P and K exhibited a decreasing trend with delay in planting beyond November 15, the effect of which was reflected in tuber yield. But tuber quality was unaffected by date of planting. Modified nutrient dose (60:30:120 kg NPK ha^{-1}) resulted in greater uptake of nutrients which improved the tuber yield and quality.

Chinese potato (*Plectranthus rotundifolius*), belonging to the family *Labiatae*, is a small herbaceous bushy annual cultivated for its tubers. The tubers have aromatic flavor and good keeping quality and are mainly used as a vegetable. The tubers are not only rich in starch, but also in minerals like calcium, iron and vitamins including thiamine, riboflavin, niacin and ascorbic acid. Although Chinese potato is a season bound crop, and the recommended time of planting is July-October (KAU, 2011), there is great scope for off season production of Chinese potato using photo-insensitive varieties. Suphala is a photo-insensitive variety released from Kerala Agricultural University with an average yield of 15.93 t ha^{-1} and duration of 120-140 days (KAU, 2007). For exploiting the yield potential of the *var*. Suphala during the off season, a study was conducted at College of Agriculture, Vellayani, Thiruvananthapuram, Kerala to fix the ideal time of planting and nutrient management. The uptake of nutrients and quality of tubers during off season were also studied.

The field experiment was conducted at the Instructional Farm attached to the College of Agriculture, Vellayani during November 2013 to May 2014.The soil of the experimental site was sandy clay loam belonging to the order Oxisol of Vellayani series. The soil was acidic with a pH of 4.62. It was high in organic carbon (1.15%) and available P (35.2 kg ha^{-1}) and low in available N (213.26 kg ha^{-1}) and K (102 kg ha^{-1}). The treatments consisted of four dates of planting (November 15, December 1, December 15 and January1) and three nutrient management practices (Recommended dose (RD) - 60:60:100 kg NPK ha^{-1} through fertilizers; RD through organic manures - 6 t FYM + 3 t coir pith compost + 3 t wood ash ha^{-1} + PGPR mix1 and Modified nutrient dose - 60:30:120 kg NPK ha^{-1} through fertilizers). The experiment was laid out in split plot design with dates of planting in main plots and nutrient management practices in sub plots with four replications. A uniform basal dose of FYM @ 10 t ha^{-1} and neem cake @ 1 t $ha^{-1}$was applied in all the plots. In organic plots, the required quantities of FYM and coir pith compost were applied as basal dose and appropriate quantity of wood ash was applied six weeks after planting. Half of the calculated quantities of urea and muriate of potash and full quantity of rock phosphate were applied to the inorganic plots as basal dose and half of urea and muriate of potash were top dressed six weeks after planting. The biofertilizer, PGPR mix 1 was applied @ 30kg ha^{-1}. Chinese potato shoot cuttings were treated with 2% slurry of PGPR mix I before planting and the remaining quantity of the biofertilizer was applied in the root zone mixed with FYM in the ratio 1:25 after planting the treated cuttings.

At harvest, the sample plants were harvested separately in order to analyze the nutrient content to work out the uptake of nutrients and to analyze the quality attributes of tubers. The sample plants uprooted were separated into shoot and tubers. Fresh weight of each part was recorded and sub samples were taken for estimating the dry weight. The sub samples were dried in a hot air oven at 70 ± 5^0C to constant dry weight. Then the dry matter of each part was worked out in kg ha^{-1}. The plant samples were then ground to pass through a 0.5 mm mesh sieve and each part was digested separately for the analysis of nutrients. The N content in plant sample was estimated by the modified micro kjeldhal method (Jackson, 1973). The P content in plant sample was calorimetrically determined by ascorbic acid method and read in a spectrophotometer (Bray and Kurtz, 1964). The K content in plant sample was determined by flame photometer method (Piper, 1966). The uptake of N, P and K was found out by multiplying N, P and K contents of tuber and shoot portion with the respective dry weights and summing up the values. The uptake values were expressed in kg ha^{-1}.

Starch content of tuber was estimated using potassium ferricyanide method (Ward and Pigman, 1970). The values were expressed as percentage on dry weight basis. Protein content (%) of tuber on dry weight basis was calculated by multiplying N content (%) in tuber with the factor 6.25 (Simpson et al., 1965).

Uptake of nutrients like N, P and K (Table 1) exhibited a decreasing trend with delay in planting, the effect of which was reflected in the tuber yield. Plants planted during November 15 had the highest uptake of nutrients and plants planted during January 1 had the lowest uptake. The study also revealed (Table 2) significant and positive correlation between uptake of nutrients and total rainfall received during the cropping period (Table 4) and with tuber yield. Total rainfall received by the crop planted on November 15 was 2.6 times greater than that for January 1 planting which might have resulted in better uptake of nutrients than November 15 planting.

Application of modified nutrient dose (60:30:120 kg NPK ha^{-1}) through fertilizers resulted in the highest uptake of N, P and K than RD (60:60:100 kg NPK ha^{-1}) through fertilizers (Table 1). It is to be noted that the uptake of N, P and K were in the same proportion in which the nutrients were supplied through modified nutrient dose (2:1:4). Lower P uptake compared to N and K uptake by Chinese potato has been observed by Kabeerathumma et al. (1987). Organic nutrition resulted in comparatively lower uptake of nutrients which might be due to the slow availability of the nutrients from the organic manures.

The results presented in Table 3 revealed no significant variation in quality attributes of tuber like starch and protein contents due to date of planting. Hence date of planting can be selected for getting higher returns from Chinese potato without sacrificing the quality of tubers

Table 1.Effect of date of planting and nutrient management on uptake of nutrients and tuber yield in Chinese potato

Treatments	Nutrient uptake (kg ha^{-1})			Tuber yield (t ha^{-1})
	N	P	K	
Date of planting				
November 15	65.40	29.70	134.92	14.89
December 1	53.67	26.04	110.22	12.80
December 15	36.48	20.46	77.69	11.82
January 1	31.19	14.23	67.22	10.71
SEm(±)	0.95	0.48	2.43	0.28
CD(0.05)	3.049	1.524	7.768	0.911
Nutrient management				
60:60:100 kg NPK ha^{-1}(RD)-fertilizers	44.22	23.00	92.01	12.39
RD through organic manures	38.75	18.53	79.85	10.94
60:30:120 kg NPK ha^{-1} -fertilizers	57.09	26.28	120.68	14.36
SEm(±)	0.66	0.39	1.17	0.130
CD(0.05)	1.932	1.159	3.412	0.381

Table 2. Correlation of uptake of nutrients with tuber yield and total rainfall during the cropping period

Characters correlated	Correlation coefficient (r)
Tuber yield x N uptake	0.939**
Tuber yield x P uptake	0.927**
Tuber yield x K uptake	0.957**
N uptake x Total rainfall	0.970*
P uptake x Total rainfall	0.894*
K uptake x Total rainfall	0.975*

** Significant at 1% level *Significant at 5% level

Table 3.Effect of date of planting and nutrient management on tuber quality attributes in Chinese potato

Treatments	Quality attributes	
	Starch (%)	Protein (%)
Date of planting		
November 15	71.83	7.12
December 1	71.63	7.06
December 15	71.48	6.60
January 1	70.80	6.59
SEm(±)	0.36	0.16
CD(0.05)	NS	NS
Nutrient management		
60:60:100 kg NPK ha^{-1} (RD)-fertilizers	71.36	6.83
RD through organic manures	70.54	6.69
60:30:120 kg NPK ha^{-1} -fertilizers	72.41	7.04
SEm(±)	0.11	0.10
CD(0.05)	0.33	NS

NS-Not significant

Table 4. Rainfall received by crops planted on different dates of planting

Treat-ments	Nov. 15	Dec. 1	Dec. 15	Jan. 1
Rainfall received (mm)	402.1	165.2	197	247

during the off season. But the starch content of the tuber varied significantly with nutrient management practices (Table 3). Modified nutrient dose (60:30:120 kg NPK ha^{-1}) through fertilizers produced the highest starch content, which might be due to its higher K dose, followed by RD (60:60:100 kg NPK ha^{-1}) through fertilizers. Adequate supply of K is necessary for the synthesis and translocation of starch. Significant influence of K levels on starch content of tuber of Chinese potato has been reported by Geetha (1983) and non significant influence of P levels has been reported by Archana and Swadija (2000) and Oomen (1989) in sweet potato. The protein content of the tuber did not vary significantly with organic and integrated nutrient management practices which were in conformity with the findings of Kolambe et al. (2013) in elephant foot yam.

For off season production of Chinese potato, planting in November 15 is ideal for higher uptake of nutrients and tuber yield without affecting the tuber quality. Modified nutrient dose (60:30:120 kg NPK ha^{-1}) through fertilizers can be recommended for higher uptake of nutrients and superior yield and quality of tuber.

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