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Time of Planting and Nutrient Management for Off-Season Production of Chinese Potato

Chinese potato (*Plectranthus rotundifolius*) is a minor tuber crop, and the tubers are used as vegetable. Unlike other vegetables, Chinese potato possesses good keeping quality. Besides being rich in carbohydrates or starch, the tubers are also rich in minerals like calcium and iron and certain vitamins including thiamine, riboflavin, niacin and ascorbic acid. Chinese potato is a season bound crop. The released varieties of Chinese potato namely Sree Dhara from ICAR-Central Tuber Crops Research Institute (ICAR-CTCRI), Thiruvananthapuram and Nidhi from Regional Agricultural Research Station (KAU), Pattambi are recommended for planting during July-October (KAU, 2011). There is great scope for off-season production of Chinese potato using photo-insensitive varieties. The tubers fetch a higher price in the market due to great demand during off-season. The Kerala Agricultural University (KAU) has released one photo-insensitive variety namely Suphala in 2006. It is a tissue culture mutant derived from local cultivar and is suited for year round cultivation. It is a high yielding (15.93 t ha^{-1}) variety with a duration of 120-140 days (KAU, 2007). An investigation was undertaken at College of Agriculture, Vellayani to find out the ideal time of planting and optimum nutrient management practices for exploiting the yield potential of the var. Suphala during the off-season.

The field experiment was conducted from 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 (35.2kg ha^{-1}) and low in available N (213.26kg ha^{-1}) and K (102kg ha^{-1}). The treatments consisted of four dates of planting (November 15, December 1, December 15 and January 1) and three nutrient management practices (Recommended dose - 60:60:100 kg NPK ha^{-1} through fertilizers; recommended dose 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 to all plots.

The required quantities of FYM and coir pith compost as per the treatments were applied as basal dose to organic plots and appropriate quantity of wood ash as per the treatment was applied six weeks after planting and incorporated into the soil. 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 was top dressed six weeks after planting and mixed with soil. The biofertilizer, PGPR mix 1 was applied @ 30 kg ha^{-1}. Chinese potato 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 of 1:25 after planting the treated cuttings. Observations on yield attributes were recorded from sample plants at harvest and yield of tubers obtained from each net plot was recorded and expressed in t ha^{-1}. Utilization index was worked out as the ratio of tuber yield to top yield on fresh weight basis.

Date of planting exerted significant influence on the yield components of Chinese potato var. Suphala (Table 1). The plants planted in November 15 registered the highest tuber number and maximum tuber weight per plant followed by the plants planted in December 1. The plants planted in December 15 or January 1 did not register any difference in the yield components. Number and weight of marketable tubers per plant showed a decreasing trend with delay in planting. It could be seen that the percentage weight of marketable tubers per plant was almost similar for the plants planted in November 15, December 1 and December 15. But a significant reduction was noticed due to late planting in January 1. The superiority of November 15 planting for better growth of Chinese potato during the off season might have contributed for its superiority in the yield components.

Table 1. Date of planting and nutrient management on yield components of Chinese potato

Treatments	Number of tubers per plant	Number of marketable tubers per plant	Weight of tubers per plant (g)	Weight of marketable tubers per plant (g)	Percentage weight of marketable tubers per plant
Date of planting					
Nov 15	12.10	7.04	89.50	81.67	91.28
Dec 01	9.04	5.25	83.13	74.17	89.01
Dec 15	8.46	4.83	76.75	66.25	86.06
Jan 01	8.17	4.33	76.75	57.92	75.26
CD (0.05)	0.580	0.380	3.072	3.770	5.295
Nutrient management					
RD-fertilizers	9.31	5.06	79.30	66.88	84.08
RD-organic manures	7.47	4.09	74.13	61.56	82.79
Modified dose- fertilizers	11.53	6.94	91.90	81.56	89.26
CD (0.05)	0.543	0.310	4.554	3.857	2.504

RD- Recommended dose NS- Not significant

Tuber yield varied significantly with date of planting (Table 2). The tuber yield exhibited a declining trend with delay in planting with the highest tuber yield of 14.89 t ha^{-1} for the plants planted in November 15 and the lowest yield of 10.71 t ha^{-1} for January 1 planting. The decreasing trend in the yield components like number and weight of marketable tubers per plant with delay in planting (Table 1) was reflected in the tuber yield. Correlation study also indicated significant and positive correlations between yield components and tuber yield as evident from Table 3. Significant influence of different time of planting on tuber yield was reported by Singh and Mandal (1976) and KAU (2008) in Chinese potato. The data in Table 2 also indicated the significant effect of date of planting on utilization index. The highest utilization index of 1.39 was obtained for the plants planted in November 15 and the lowest utilization index of 1.28 for plants planted in January 1. This might be due to the decreasing trend exhibited in tuber yield with delay in planting beyond November 15.

Table 2. Date of planting and nutrient management on tuber yield and utilization index of Chinese potato

Treatments	Tuber yield (t ha^{-1})	Utilization index
Date of planting		
Nov 15	14.89	1.39
Dec 1	12.80	1.34
Dec 15	11.82	1.31
Jan 1	10.71	1.28
CD(0.05)	0.911	0.036
Nutrient management		
RD-fertilizers	12.39	1.33
RD-organic manures	10.94	1.24
Modified dose-fertilizers	14.36	1.42
CD(0.05)	0.381	0.042

RD- Recommended dose NS- Not significant

An average yield of 20.99 t ha^{-1} was realized for the var. Suphala during the normal planting season of Chinese potato from July to October (Atul et al., 2013). KAU (2007) reported an average yield of 15.93 t ha^{-1} for the var. Suphala. Comparable tuber yield was obtained for the plants planted in November 15 in the present study during off-season. It was also possible to realize a tuber yield of 10.71 t ha^{-1} during the off-season when the crop was planted late on January 1. It is noteworthy that 14.89 to 10.71 t ha^{-1} of tuber yield could be realized during the off season of Chinese potato within an average duration of four months. Hence there is scope for profitable cultivation of Chinese potato var. Suphala in the summer rice fallows.

A perusal of the weather data during the cropping period indicated that there is considerable variation in the total rainfall received by the crop planted on different dates. The crop planted on November 15, December 1, December 15 and January 1 received a total of 394.8, 253.8, 154 and 150 mm of rainfall respectively. When the rainfall data was correlated with yield data, it was observed that the number of marketable tubers per plant and tuber yield were significantly and positively correlated with total rainfall during the cropping period (Table 3).

Table 3. Correlation of different parameters with yield

Sl. No.	Characters	Correlation coefficient (r)
1.	Yield x Number of tubers per plant	0.968**
2.	Yield x Number of marketable tubers per plant	0.974**
3.	Yield x Weight of tubers per plant	0.950**
4.	Yield x Weight of marketable tubers per plant	0.975**
5.	Number of marketable tubers per plant x Total rainfall	0.975*
6.	Weight of marketable tubers per plant x Total rainfall	0.929
7.	Yield x Total rainfall received during cropping period	0.970*

**Significant at 1 %, *Significant at 5 %

Hence the variation in tuber yield might be due to the variation in the total rainfall received by the crop planted on different dates. The crop which was planted in November 15 received 2.6 times higher rainfall than the crop planted in January 1 which might have resulted in 39 % increased yield for November 15 planted crop.

Nutrient management practices significantly influenced the yield components like number and weight of tubers per plant and number and weight of marketable tubers per plant (Table 1). Modified nutrient dose (60:30:120 kg NPK ha^{-1}) through fertilizers produced maximum values of these yield components which might be due to its profound influence on growth characters. The recommended dose (60:60:100 kg NPK ha^{-1}) of fertilizers produced higher yield than the same dose of organic manures. The sufficiency of 30 kg P_2O_5 ha^{-1} for getting higher values of yield components of Chinese potato was reported by Archana and Swadija (2000). The highest percentage weight of marketable tubers per plant was recorded for the modified nutrient dose through fertilizers while no conspicuous variation was noted between recommended dose through fertilizers and organic manures.

The data in Table 2 indicated significant influence of nutrient management practices on tuber yield. The profound influence of modified dose of nutrients was reflected in tuber yield. Application of modified nutrient dose (60:30:120 kg NPK ha^{-1}) through fertilizers combined with FYM @ 10 t ha^{-1} recorded significantly higher tuber yield of 14.36 t ha^{-1} than the recommended dose of nutrients (60:60:100 kg NPK ha^{-1}) through fertilizers. The modified nutrient dose resulted in an yield increase of 16 % over the recommended dose of nutrients. The crop response to lower P and higher K levels might be due to high available P and low available K status of the soil which is in agreement with the findings of Geetha (1983) and Archana and Swadija (2000). The recommended dose of nutrients (60:60:100 kg NPK ha^{-1}) through fertilizers registered significantly higher tuber yield (12.39 t ha^{-1}) than the same dose through organic manures (10.94 t ha^{-1}), both treatments combined with a uniform dose of FYM @ 10 t ha^{-1}. The integrated nutrient management practice resulted in 16% yield increase over organic nutrition. The significant effect of integrated nutrient management practice on yield components might have culminated in its significant effect on tuber yield. The superiority of integrated nutrient management practice over organic nutrition on crop growth and tuber yield of elephant foot yam was reported by Kolambe et al., (2013).

The effect of nutrient management practices on utilization index (Table 2) showed the same trend on tuber yield. The highest utilization index of 1.42 could be obtained for the modified nutrient dose through fertilizers. Geetha (1983) suggested application of lower dose of P and higher dose of K (as included in the modified nutrient dose in the present study) for producing higher utilization index in Chinese potato. The recommended dose through fertilizers registered a higher utilization index (1.33) than the same dose through organic manures.

The study revealed that for off-season production of Chinese potato var. Suphala in the southern zone of Kerala, the ideal time of planting is November 15 which recorded higher tuber yield. Modified nutrient dose of 60:30:120 kg NPK ha^{-1}through fertilizers + FYM @ 10 t ha^{-1} + neem cake @ 1 t ha^{-1} can be recommended for the crop for getting higher tuber yield.

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