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Influence of different levels of NPK on flowering, fruit yield and alkaloid content of Thuthuvalai (*Solanum trilobatum* L.)

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ABSTRACT

Thuthuvalai (*Solanum trilobatum* L.) is an important medicinal plant in Indian system of medicines. The fruits are having several alkaloids. These alkaloids have been identified and used in large scale by pharmaceutical industries for formulating new drugs against many diseases and illness of human beings. In order to exploit this medicinal herb for commercial cultivation, the present investigation was carried out to study the effect of different levels of NPK, on flowering fruit yield and alkaloid content of Thuthuvalai (*Solanum trilobatum* L.). The treatment consisted of three levels each of Nitrogen (N): 25, 50 and 75 kg ha^{-1} Phosphorus (P): 20, 40 and 60 kg ha^{-1} and Potassium (K): 20, 40 and 60 kg $ha.^{-1}$ The result revealed that the higher levels, N_3, P_3 and K_3 (75: 60: 60 Kg ha^{-1}) recorded maximum number of fruits per plant, fruit diameter and fresh and dry fruit yield. The P_3 and K_3 levels were on par with P_2 and k_2 levels for the most of the parameters and significantly higher than P_1 and K_1 levels. Among the interaction, the higher level N_3 and P_3 registered maximum growth and yield parameters at all the stages of observations. The chlorophyll content, total soluble protein and photosynthetic rate were maximum at N_3 and P_3 levels. The nitrate reductase activity, proline and alkaloid contents in the fruits were higher at N_3, P_3 and K_3 levels and N_3 P_3 interaction.

Keywords: Thuthuvalai (*Solanum trilobatum* L.), flowering, fruit yield, alkaloid content

Introduction

The green medicinal herb, Thuthuvalai (*Solanum trilobatum* L.) is one such green remedy in ISM and Homeopathy. Thuthuvalai (*Solanum trilobatum* L.), belonging to the family Solanaceae, is a branched climbing shrub with sharp and curved prickles. This medicinal plant is commonly found in the regions of South and North West India. It is a well-known medicinal plant, used for curing all kinds of lung disorders. The fruits of this medicinal plant are also used as vegetable.

The steroidal alkaloid, solasodine is present in the fruits of Thuthuvalai (Barnabas *et al.*, 1989). All parts of this plant are used against asthma, chronic febrile affections and difficult parturition. TIn the Sidha system of medicine, paste prepared from this plant is used to cure tuberculosis (Raman and Jaiwal, 2000). It is mostly found growing naturally in forests. It is not always possible to sustain regular supplies for an established industry from natural sources due to difficulties offered to uncertain collections from hilly terrain where they usually occur naturally. The medicinal properties and over exploitation necessitate, extensive cultivation of this crop.

Though it is popularly grown in home garden as medicinal herb, until now there is no information on crop management. So far, no systematic work has been made to standardize nutrient requirement for Thuthuvalai. Hence, the present investigation was undertaken to find out the optimum dose of NPK for maximize fruit yield and alkaloid content.

Materials and Methods

The experiment was carried out at the Botanical Garden, Department of Medicinal and Aromatic Crops, Horticultural College and Research Institute, TNAU, Coimbatore. The seeds were sown in nursery beds. Forty five days old seedlings were transplanted in main field at a spacing of 60 x 30 cm in a factorial randomized block design (FRBD) with three replications. The treatment consisted of three levels each of Nitrogen (N): 25, 50 and 75 kg ha^{-1} Phosphorus

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(P): 20, 40 and 60 kg ha^{-1} and Potassium (K): 20, 40 and 60 kg ha^{-1} the 50 per cent of nitrogen, 100 per cent of phosphorus and potassium were applied as basal dose. The remaining 50 per cent of nitrogen was applied in two equal split doses at 6 and 10 weeks after transplanting.The observations were recorded on Flower diameter (cm), No. of fruits ($plant^{-1}$), Fruit colour, Fruit diameter (cm), Fresh fruit yield (g $plant^{-1}$), Dry fruit yield (g $plant^{-1}$), No. of seeds (fruit $^{-1}$), Seed colour, Seed yield (g $plant^{-1}$), Proline content (µg g^{-1}), Alkaloid content in fruit(%). The data generated through this investigation was analyzed by the statistical method of Panse and Sukhatme (1961) [11].

Results and Discussion

The fruit yield in the present investigation was determined as fresh and dry fruit yield per plant as well as per hectare basis. Application of N, P and K exerted a positive influence on fruit yield and its attributes such as number of fruits and fruit diameter. All the parameters were significantly influenced by the application of different levels of N, P and K in the present study. The increase in yield was associated with a corresponding increase in number of fruits per plant and fruit diameter. Increase in yield could be due to increase in plant height, stem girth, number of leaves, leaf area and also higher nutrient uptake by the plants. This is in confirmation with the finding of Pareek *et al.* (1980) [12] in senna and Rahul and Kadam (2010) [13] in cucumber. The lower yield at lower levels might probably be due to the low uptake of nutrients and consequent low dry matter production.

With regard to interaction of NPK, the results reveal that the interaction of N and P levels alone had significant influence on fruit yield in Thuthuvalai. However the highest fruit yield was recorded in N_3, P_3 and K_3 interaction. Among the N and P interactions, the N_3P_3 interaction recorded higher yield, which was on par with the interaction level of N_3P_2. It might be optimum for getting maximum fruit yield where the higher levels of N might have been responsible for the growth and development of plants rather than the higher levels of P. Least fruit yield in the N_1P_1 interaction might be because of insufficient availability of these nutrients to meet the genetic yield potential. It was also reflected in both the growth and yield parameters as well as dry matter production. Nair (1984) [9], Nandekar and Sawarkar (1990) [10], Sharma *et al.* (1996) [14] and Gupta and Pareek (1981) [3] reported significant N and P interaction effect on yield of *Solanum khasianum*, brinjal, chilli and senna respectively.

The total alkaloid content in fruit at 180 DAS was estimated. The application of nutrients exerted significant influence on synthesis and accumulation of total alkaloid content. The total alkaloid content in fruit was maximum at higher level of N application (75 $kgha^{-1}$) (Fig.7). It is attributable to higher chlorophyll content of leaf which is responsible for synthesis of alkaloids. The plant in this treatment were able to convert nitrate to nitrite in an effective manner, which reflected in higher nitrate reductase activity (Fig.10). The plants having higher chlorophyll content and nitrite form of nitrogen must have also had higher photosynthetic rates. The photosynthetic rate measured in terms of total soluble protein (Fig.10) also indicated the higher physiological activities of plants at higher level of nitrogen. This is coinciding with the reports of Nair (1984) [9] in *Solanum khasianum*, Pareek *et al.* (1989) in Senna, Becker *et al.* (2000) [2] in *Phyllanthus amarus* and Maurya *et al.* (1999) [8] in sarpagandha.

In the present study the P and K application influenced in the alkaloid content of fruit (Fig.7). Though higher levels of P and K (P_3 and K_3) recorded higher alkaloid contents it was on par with the next lower levels (P_3 and K_2). The higher alkaloid content at these levels might be attributed to better root development caused by P and involvement of K in the various biosynthetic pathways of alkaloids as catalyst. Therefore P_2 and K_2 level may be optimum for its full expression of genetic potential. Similar results were recorded in *Solanum nigrum* by Khan *et al.* (2000) [6], *Solanum khasianum* by Nair (1984) [9] and Law *et al* (2009) [7] in tonmato. Interaction of N and P alone influenced the total alkaloid content. The N_3P_3 level recorded higher alkaloid content, which was not significantly higher than that of N_3P_2 level. This may be due to the utilization of N in higher quantity for build up of herbage rather than the P. Observations of Nair (1984) [9] in *Solanum viarum*, and Kattimani *et al.* (2001) [5] in mint are also in close agreement with the present findings. Proline content in the leaves also increased with the application of NPK fertilizers. The higher proline content in leaves at higher doses of N, P and K indicates that the absorbed nutrients were translocated and utilized in the formation of amino acids which are the metabolic reserve material and also serve as a source to the sink during the reproductive process. This result is similar to that of Ilangovan *et al.* (1991) [4] in senna Subbaraj and Thamburaj (1997) [15] in *Gymnema sylvestre*. and Aminifard *et al* (2012) [1] innsweet pepper.

Thus it is evident that, application of NPK @ 75:40:40 kg ha^{-1} is optimum for maximizing the yield of fruit yield and alkaloid content in Thuthuvalai

Table 1: Effect of different levels of N, P and K on days to flowering, No. of fruits ($plant^{-1}$), Fruit diameter (cm), in Thuthuvalai (*Solanum trilobatum* L.)

Treatment		Days to flowering				No. of fruits ($plant^{-1}$)				Fruit diameter (cm)			
		N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
P_1	K_1	89.04	94.86	107.66	97.19	144.44	152.91	170.86	156.07	1.00	1.10	1.26	1.12
	K_2	91.79	97.64	110.41	99.95	148.82	156.64	174.74	160.07	1.04	1.15	1.30	1.16
	K_3	91.92	98.01	110.92	100.28	149.13	157.11	175.31	160.52	1.05	1.15	1.31	1.17
	Mean	90.92	96.84	109.66	99.14	147.46	155.55	173.64	158.88	1.03	1.13	1.29	1.15
P_2	K_1	100.96	113.85	122.69	112.50	160.89	178.96	189.98	176.61	1.20	1.36	1.41	1.32
	K_2	103.84	116.72	125.98	115.51	164.68	182.88	194.58	180.71	1.21	1.36	1.41	1.33
	K_3	104.06	117.86	126.82	116.25	165.83	184.16	194.99	181.66	1.21	1.36	1.41	1.33
	Mean	102.95	116.14	125.16	114.75	163.80	182.00	193.18	179.66	1.21	1.36	1.41	1.33
P_3	K_1	101.28	114.91	123.41	113.20	162.04	180.45	191.23	177.91	1.20	1.36	1.41	1.32
	K_2	104.45	118.93	127.96	117.11	166.52	185.59	196.48	182.86	1.21	1.36	1.41	1.33
	K_3	104.87	119.24	128.51	117.54	167.01	186.14	197.69	183.61	1.22	1.36	1.42	1.33
	Mean	103.53	117.69	126.63	115.95	165.19	184.06	195.13	181.46	1.21	1.36	1.41	1.33
	K_1	97.09	107.87	117.92	107.63	155.79	170.77	184.02	170.20	1.13	1.27	1.36	1.25
	K_2	100.03	111.10	121.45	110.86	160.01	175.04	188.60	174.55	1.15	1.29	1.38	1.27

	K3	100.28	111.70	122.08	111.36	160.66	175.80	189.33	175.26	1.16	1.29	1.38	1.28
	Mean	99.13	110.22	120.48	109.95	158.82	173.87	187.32	173.34	1.15	1.28	1.37	1.27
Source		**SEd**		**CD (P = 0.05)**		**SEd**		**CD(P = 0.05)**		**SEd**		**CD(P = 0.05)**	
N		0.81		1.62		1.27		2.55		0.01		0.02	
P		0.81		1.62		1.27		2.55		0.01		0.02	
K		0.81		1.62		1.27		2.55		0.01		0.02	
N × P		1.40		2.80		2.20		4.41		0.02		0.03	
P × K		1.40		NS		2.20		NS		0.02		NS	
N × K		1.40		NS		2.20		NS		0.02		NS	
N × P × K		2.42		NS		3.81		NS		0.03		NS	

Table 2: Effect of different levels of N, P and K on Fresh fruit yield (g plant^{-1}) and Fresh fruit yield (t ha^{-1})in Thuthuvalai (*Solanum trilobatum* L.)

Treatment		**Fresh fruit yield (g plant^{-1})**				**Fresh fruit yield (t ha^{-1})**			
		N1	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**
P1	K1	101.39	107.98	121.98	110.45	2.676	2.850	3.219	2.915
	K2	104.51	111.02	124.63	113.39	2.758	2.930	3.289	2.992
	K3	104.92	111.49	125.32	113.91	2.769	2.942	3.307	3.006
	Mean	103.61	110.16	123.98	112.58	2.734	2.907	3.272	2.971
P2	K1	114.25	128.09	135.12	125.82	3.015	3.380	3.566	3.320
	K2	116.99	130.79	137.87	128.55	3.087	3.452	3.638	3.392
	K3	118.39	131.96	138.94	129.76	3.124	3.482	3.667	3.424
	Mean	116.54	130.28	137.31	128.04	3.076	3.438	3.624	3.379
P3	K1	115.61	129.25	136.22	127.03	3.051	3.411	3.595	3.352
	K2	118.82	132.14	139.45	130.14	3.136	3.487	3.680	3.434
	K3	119.23	132.39	139.82	130.48	3.146	3.494	3.690	3.443
	Mean	117.89	131.26	138.50	129.21	3.111	3.464	3.655	3.410
	K1	110.42	121.77	131.11	121.10	2.914	3.214	3.460	3.196
	K2	113.44	124.65	133.98	124.02	2.994	3.290	3.536	3.273
	K3	114.18	125.28	134.69	124.72	3.013	3.306	3.555	3.291
	Mean	112.68	123.90	133.26	123.28	2.974	3.270	3.517	3.253
Source		**SEd**		**CD(P = 0.05)**		**SEd**		**CD(P = 0.05)**	
N		0.90		1.81		0.024		0.048	
P		0.90		1.81		0.024		0.048	
K		0.90		1.81		0.024		0.048	
N × P		1.56		3.14		0.041		0.083	
P × K		1.56		NS		0.041		NS	
N × K		1.56		NS		0.041		NS	
N × P × K		2.71		NS		0.071		NS	

Table 3: Effect of different levels of N, P and K on Dry fruit yield (g plant^{-1}) and Dry fruit yield (t ha^{-1}) and Alkaloid content (%)in Thuthuvalai (*Solanum trilobatum* L.)

Treatment		**Dry fruit yield (g plant^{-1})**				**Dry fruit yield (t ha^{-1})**				**Alkaloid content (%)**			
		N1	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**	**N1**	**N2**	**N3**	**Mean**
P1	K1	28.38	30.42	34.34	31.05	0.749	0.803	0.906	0.819	1.080	1.170	1.290	1.180
	K2	29.21	31.12	35.29	31.87	0.771	0.821	0.931	0.841	1.120	1.200	1.320	1.213
	K3	29.54	31.33	35.51	32.13	0.780	0.827	0.937	0.848	1.130	1.200	1.330	1.220
	Mean	29.04	30.96	35.05	31.68	0.766	0.817	0.925	0.836	1.110	1.190	1.313	1.204
P2	K1	32.28	36.26	38.27	35.60	0.852	0.957	1.010	0.940	1.230	1.370	1.460	1.353
	K2	33.06	36.99	38.99	36.35	0.872	0.976	1.029	0.959	1.250	1.410	1.490	1.383
	K3	33.32	37.42	39.13	36.62	0.879	0.988	1.033	0.966	1.250	1.410	1.490	1.383
	Mean	32.89	36.89	38.80	36.19	0.868	0.974	1.024	0.955	1.243	1.397	1.480	1.373
P3	K1	32.57	36.57	38.41	35.85	0.860	0.965	1.014	0.946	1.230	1.370	1.460	1.353
	K2	33.46	37.49	39.26	36.74	0.883	0.989	1.036	0.969	1.260	1.420	1.490	1.390
	K3	33.51	37.53	39.42	36.82	0.884	0.990	1.040	0.972	1.260	1.420	1.490	1.390
	Mean	33.18	37.20	39.03	36.47	0.876	0.982	1.030	0.962	1.250	1.403	1.480	1.378
	K1	31.08	34.42	37.01	34.17	0.820	0.908	0.977	0.902	1.180	1.303	1.403	1.296
	K2	31.91	35.20	37.85	34.99	0.842	0.929	0.999	0.923	1.210	1.343	1.433	1.329
	K3	32.12	35.43	38.02	35.19	0.848	0.935	1.003	0.929	1.213	1.343	1.437	1.331
	Mean	31.70	35.01	37.62	34.78	0.837	0.924	0.993	0.918	1.201	1.330	1.424	1.319
Source		**Sed**		**CD(P = 0.05)**		**SEd**		**CD(P = 0.05)**		**SEd**		**CD(P = 0.05)**	
N		0.03		0.51		0.007		0.013		0.010		0.019	
P		0.03		0.51		0.007		0.013		0.010		0.019	
K		0.03		0.51		0.007		0.013		0.010		0.019	

N × P	0.44	0.89	0.012	0.023	0.017	0.034
P × K	0.44	NS	0.012	NS	0.017	0.034
N × K	0.44	NS	0.012	NS	0.017	0.034
N × P × K	0.76	NS	0.020	NS	0.029	0.058

Summary

The present investigation stated that The higher levels of N, P and K (N_3, P_3 and K_3) influenced days to flowering. The different levels of N, P and K showed significant influence on yield and yield attributes. The higher levels, N_3 and P_3, P_1, K_3 and K_2 had significantly higher fresh and dry fruit yield, number of fruits per plant and fruit diameter. Among the various interactions of NPK, NP had significant influence on number of fruits per plant, fresh and dry fruit yield, number of seeds per plant and seed yield. The physiological parameters namely, nitrate reductase activity, proline content and total alkaloids content in the fruit at 180 DAS were significantly higher in N_3, P_3 and K_3 levels. However, P_3 and K_3 levels on par with P_2 and K_2 levels whereas the higher content of chlorophyll, total soluble protein and photosynthetic rate were observed in N_3 and P_3 levels.

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