Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 2340-2344

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Estimation of nitrogen uptake in tomato variety srijana by spad meter under greenhouse condition

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Abstract
Nitrogen has direct role on development and yield of crops. With an objective to find out the best treatment combination for nitrogen uptake, this research was conducted using ten different treatments with five replications in RCBD design. The treatments were T_1 (Control), T_2 (2% compost added), T_3 (2% compost + NPK full dose), T_4 (T_3+ Biochar @ 4t/ha), T_5 (T_2 + biochar @ 4t/ha + 50ml cattle urine per pot), T_6 (T_2 + biochar @ 4t/ha + 50ml cattle urine at hotspot), T_7 (T_3 + 8t/ha biochar), T_8 (T_5 at 8t/ha biochar), T_9 (T_6 at 8t/ha biochar), T_{10} (compost at 4%). Srijana variety of tomato was used for this research. Observations were made for Soil Plant Analysis Development (SPAD) reading, plant height, number of fruits, fruit yield and soil nitrogen content and the obtained data were analyzed using Analysis of Variance (ANOVA). SPAD reading showed a non-significant variation among the treatments. The correlation between SPAD readings and total nitrogen in soil was found statistically non significant and least positively correlated. Highest mean value of plant height was obtained from T_2 of 1-7.03cm. T_3 gave the highest number of fruits of 68. There was significant difference on total fruit yield having T_{10} the highest fruit yielding treatment of 1.523kg. There was high significant difference on total soil nitrogen and most of the soil had total nitrogen content ranging from high to medium with T_1 having lowest nitrogen content

Keywords: Nitrogen uptake, SPAD meter, Tomato, Yield

Introduction
Tomato (*Licoperscionesculentum L)* is a warm season crops requiring 26-32^{0}C temperature for seed germination while 15-27^{0}C for its cultivation and grows well in well drained sandy loam soil (agriinfo), requiring 200:180:180 kg/ha N:P:K (agritech). It has become one of the major commercial vegetable crops in the world because of its great performance and adaptability to various agro climatic conditions. According to FAO (2002), it lies third in terms of global vegetable production after potato and sweet potato. In 2014, 170.8 million tones of tomatoes were produced worldwide, with China accounting 31% of the total followed by India (11%). Nepal produced tomato about 0.3 million MT annually cultivated about 20,000 hectares ranking it in the 3rd most important vegetable after cauliflower and cabbage in terms of area and production (MoAD,2014). However comparing with the average yield of world (26.74MT/ha) and Asia (2,430MT/ha) (FAO 2003) average yield of Nepal is pretty less. Nepal have released 4 varieties of tomato and 28 varieties registered (NARC, 2014), among them Srijana variety of tomato is widely preferred and accepted by the farmers and is also widely popular for commercial tomato farming due to its less susceptibility to bacterial wilt disease, good taste and higher adaptability for off seasonal production. Therefore farmers are particularly recommended for its commercial farming under plastic house (Chapagain *et al*., 2010; Pokharel and Thakur 2012).
Tomato significantly shows the effect in its growth and yield on the consequent supply of the nitrogen (Xin *et al*., 1997) and significantly increases its production when proper amount of Nitrogen is supplied (Bose and Som, 1990). Higher supply and uptake of the nitrogen highly affects in the growth and yield of Tomato. Nitrogen uptake can be affected by various factors such as variety of the plant, temperature, supplied fertilizers, growth stage of the plant etc. According to the trials conducted in California in 2007-2008 by Hartz and Bottoms, nitrogen uptake in tomato was low in early season. The nitrogen uptake increased as the growth of the plant and it remained relatively high until harvest. It was also stated that approximately 70% of the total above ground nitrogen was in tomatoes and rest was in the vines (Harts and Bottoms, 2009).
Nitrogen uptake in the standing plant can be measured by a light weighted hand held meter called SPAD (Soil Plant Analysis Development) which measures the chlorophyll content of leaves without causing any damage to plants. The SPAD meter determines the relative amount

of chlorophyll present in leaf by measuring the absorbance of the leaf in two wavelength regions (650 and 940). The chlorophyll content in turn is directly related to the nitrogen uptake by plants from the soil. Chlorophyll content is approximately proportional to leaf nitrogen content (Evans, 1983). Higher the SPAD value shows higher will be the concentration of chlorophyll per leaf unit area. It was released by Minolta Co. Ltd, Japan in 1984. The major objective of the study was to find the best treatment combinations for optimum uptake of nitrogen by Tomato. The specific objectives were to find out the chlorophyll concentration in leaves at different stages of plant growth, to assess the yield of tomato as influenced by different treatments and to observe the residual effect of nitrogen in different treatments on the soil nitrogen.

1. Materials and Methodology

2.1 Experimental Site

The study was carried out from June 2017 to September 2017 in the greenhouse of the Soil Science Division of Nepal Agriculture Research Council (NARC)(Khumaltar, Lalitpur, Nepal, latitude of $29^0$39'8.0'', longitude of $85^0$19'35.2'', elevation 1327masl). Srijana variety of tomato was grown singly on earthen pots according to a completely randomized design with five replications where ten treatments were compared. The treatments were T_1(control), T_2(2% compost), T_3(2% compost + NPK full dose), T_4 (T_3+ Biochar @ 4t/ha), T_5 (T_2 + biochar @ 4t/ha + 50ml cattle urine per pot), T_6 (T_2 + biochar @ 4t/ha + 50ml cattle urine at hotspot), T_7 (T_3 + 8t/ha biochar), T_8 (T_5 at 8t/ha biochar), T_9 (T_6 at 8t/ha biochar), T_{10} (compost at 4%).

The same irrigation volume was applied daily for all treatments for initial 15days after transplantation (DAT) which was then reduced to every other day and then irrigated when needed during the last days of the research period. Similarly weeding, pruning and staking was done when needed at required time.

1.2 Data collection

The SPAD meter data was taken from the 3 apical leaves of the youngest fully expanded top leaves in the interval of 20 days at 20DAT, 40DAT, 60DAT and 80DAT. Plant height was first measured at 35 DAT and then at the interval of 20 days at 55DAT and 75DAT. Two fruit parameters i.e. number of fruits and fruit yield were taken when the plant started to give fruit. Since Srijana variety of tomato is indeterminate type no specific time interval was followed during fruit data collection. Data were collected when the fruiting occurred. After all the fruits were harvested plants were uprooted from the soil and soil sample was taken for total soil nitrogen analysis which was determined by kjeldahl digestion method.

1.3 Statistical Analysis

The data recorded from different parameters were analyzed statistically with the help of SPSS version 23.0. Analysis of variance (ANOVA) was done for proper interpretation of collected data. The results obtained are presented at 5% level of significance (P=0.05). P-value, F-value, grand mean, least significant difference (LSD), standard error of mean were calculated to compare the significant result.

2. Results Discussions

Table 1 shows the differences in the plant height in response to different treatments applied. Plant height only showed significant differences on 1st reading i.e. on 35 DAT while no any significant differences were seen upon maturity having p-value higher than 0.05. On 35 DAT plants grown on the soil treated with 4% compost (T_{10}) had the highest plant height (83.70cm) followed by T_2 (82.20cm), T_7 (78.90cm), T_9(78.50cm) while lowest plant height was given by T_1(control soil) which was 65.20cm. The height of the plant was found to be highest on T_2 both on 55DAT and 75DAT while T_1 gave the lowest plant height on 55DAT and on 75DAT T_3 gave the lowest plant height. It was obvious to obtain lowest plant height in T_1 (control soil) due to low nutrient content as compared to other.

Table 1: Effects of different treatments on plant height

Treatments	Average Plant Height(cm)			Mean
	35 DAT	55DAT	75DAT	
T_1	65.20	87.38	113.90	88.83
T_2	82.20	111.98	126.90	107.03
T_3	69.30	96.02	105.56	90.29
T_4	69.90	97.76	115.10	94.25
T_5	62.60	98.20	114.16	91.65
T_6	75.40	104.66	121.50	100.78
T_7	78.90	99.70	120.94	99.84
T_8	71	100.28	115.80	96.09
T_9	78.5	102.90	118.40	99.93
T_{10}	83.7	109.32	119.10	104.04
P-value	**0.03**	**0.09**	**0.96**	**0.33**
F-value	2.30	1.87	0.33	1.20
Grand Mean	73.67	100.82	117.14	97.27
SEM	1.66	1.74	2.97	1.78

Table2 shows the data regarding number of fruits in different harvest as affected by various treatments. The application of different treatments drastically affected the tomato fruit number. However, p-value for all harvest was found greater than 0.05 which is statistically non-significant; the total number of fruits was statistically significant with p-value less than 0.05.

Table2. Effects of treatments on total number of fruits

Treatments	Total number of fruits				Total
	1st harvest	2nd harvest	3rd harvest	4th harvest	
T_1	1	7	8	15	31
T_2	5	7	26	11	49
T_3	2	12	39	16	68
T_4	4	19	9	11	43
T_5	7	10	32	12	61
T_6	4	10	20	18	52
T_7	6	20	23	4	53
T_8	6	11	21	11	49
T_9	6	11	17	9	43
T_{10}	8	14	10	21	53
P-value	**0.64**	**0.08**	**0.23**	**0.41**	**0.02**
F-value	0.78	1.91	1.37	1.07	2.62
Grand Mean	5	11	20	13	50.2
SEM	0.16	7.01	7.94	0.30	11.07

The highest total number of fruit was obtained in treatment T_3 with total number of 68 and the lowest was in treatment T_1 (31) i.e. control. 3rd harvest gave the highest number of fruits with the mean of 20 followed by 4th, 2nd and 1st harvest. So, from this research it can also be said 70-75 DAT was the highest fruiting period.

Table 3 shows the data recorded on fruit yield as affected by different treatments. Fruit yield was not significantly affected

by different treatments on different harvest. The total yield after all four harvests was found to be significantly affected with the p-value of 0.02.

Table 3: Effects of different treatments on Fruit Yield (g/plant)

Treatments	Average Fruit Yield (g/plant)				Total
	1st harvest	2nd harvest	3rd harvest	4th harvest	
T_1	33	250	159	197	639
T_2	165	176	391	156	888
T_3	15	311	499	156	981
T_4	155	555	173	156	1039
T_5	248	278	630	133	1289
T_6	150	288	429	255	1122
T_7	150	529	377	79	1135
T_8	225	354	377	120	1076
T_9	161	349	372	123	1005
T_{10}	277	500	419	327	1523
P-value	**0.69**	**0.08**	**0.23**	**0.41**	**0.02**
F-value	0.72	1.19	1.37	1.07	2.62
Grand Mean	31.58	74.06	74.66	34.82	213.10
SEM	6.09	7.01	7.94	5.10	11.07
LSD	52.39	60.75	65.62	39.22	78.77
CV%	129.3	64.0	68.5	87.8	28.8

Closer observation of data in Table 3 showed that the treatment T_{10} gave the highest yield in most of the harvest except in 2nd one while the total yield of other treatments were quite fluctuating between different harvest. The total yield ranged from lowest 639g which was given by T_1 to highest 1523g which was given by $T_{10.}$ The fruit yield due to different treatments ranked on the order of T_{10}> T_5> T_7 > T_6> T_8> T_4> T_9> T_3> T_2> T_1. The better performance of tomato crop in terms of yield was observed when compost alone was given at 4%. This result goes in contrast with the findings of Khan et.al., (2017) who reported the higher yield in Tomato when compost was combined with inorganic fertilizer. But the findings go along with Duraisamy et.al., (1999) where the fruit yield was higher in crops supplied with organic fertilizers than those supplied with inorganic nitrogen. Among the organic fertilizers where A. brasilense culture (applied by dipping seedling roots in 200g/10 litres, or soil application of 2 kg/ha), composted coir pith (CCP, 12.5 t/ha) and farmyard manure (FYM, 12.5 t/ha) were applied to rainfed tomatoes, CCP resulted in the highest fruit yield (14.68 t/ha).

The residual effect of different treatments on the soil is presented in Table 4 below.

Table 4: Residual effects on soil nitrogen by different treatments

Treatments	Total Soil Nitrogen (%)
T_1	0.03
T_2	0.72
T_3	0.76
T_4	0.17
T_5	0.06
T_6	0.09
T_7	0.19
T_8	0.13
T_9	0.76
T_{10}	0.76
P-value	**<0.01**
F-value	63.09
Grand Mean	0.39
SEM	0.04

The effects of treatments were found statistically significant to total soil nitrogen percentage giving p- value less than 0.01 for all the treatments. According to SMD (2010), soil having nitrogen% above 0.4 is considered very high, N% between 0.2-0.4 is considered high, 0.1-0.2 as medium, and 0.05-0.1 as low and below 0.05 as very low. The highest nitrogen % was found in treatment $T_{3,}$ T_9 and T_{10} with the value of 0.76 which is considered very high by SMD (2010) followed by T_2, T_7, T_4, T_8, T_6, T_5 and $T_{1.}$ Treatment T_9 and T_{10} consists of organic sources of fertilizers while treatment T_3 comprises of both organic and inorganic sources. The residual nitrogen content in soil after plant harvest was found high in case of these treatments so it can be said that these treatments supplied more nitrogen to soil as compared to other treatments. Parmar and Sharma (2002) reported that application of fertilizers from chemical nitrogen sources, organic nitrogen sources increased soil total nitrogen. Wiqar *et al*., (2013) also concluded increase in soil total nitrogen by the integrated use of fertilizers. Control showed the lowest nitrogen content as compared to other treatments which goes along with the findings of Khali *et al*., (2001) where control resulted in the significantly lowest response with respect to different

agronomic characters under study. Despite cattle urine being richest source of nitrogen but the treatments where the cattle urine was used i.e. treatments T_5 and T_6 showed low nitrogen content in the soil after plant harvest. This may be due to the leaching of cattle urine.

Table 5 shows the data regarding average SPAD meter reading of leaves of tomato plant at the interval of 20 days. The effect of different treatments on the SPAD reading was found statistically non-significant at different days with p-value greater than 0.05 in all cases.

Table 5: Effects of different treatments on SPAD meter readings

Treatments	Average reading of SPAD meter				Mean
	20DAT	40 DAT	60DAT	80DAT	
T_1	41.94	42.09	40.81	39.58	41.10
T_2	44.49	46.69	45.17	39.93	44.19
T_3	40.27	48.71	46.93	43.26	44.79
T_4	45.87	54.78	44.95	43.34	47.23
T_5	40.54	51.88	47.04	43.01	45.62
T_6	41.88	50.31	43.17	39.03	43.60
T_7	45.00	53.17	45.11	38.48	45.44
T_8	44.32	53.41	50.39	44.23	48.09
T_9	41.52	47.23	47.21	40.65	44.15
T_{10}	45.25	49.07	46.81	44.03	46.29
P-value	**0.05**	**0.14**	**0.37**	**0.57**	**0.18**
F-value	2.14	1.63	1.12	0.86	1.50
Grand Mean	43.16	49.73	45.76	41.55	45.05
SEM	0.51	1.00	0.78	0.75	0.53

SPAD reading above 35 means there is enough nitrogen content in the plant sample and it is not necessary to apply additional nitrogen during growth stage of crop (Fallah, 2012). In the 1st and 2nd reading i.e. 20 DAT and 40 DAT highest average value for chlorophyll content in leaves was found in treatment T_4 with the value of 45.78 and 54.78 respectively. This findings go along with Ceylan *et al*., (2001) who conducted a field experiment to assess the effect of ammonium nitrate and urea fertilizers on nitrogen uptake and accumulation in tomato plants under field conditions. On the first and second harvest dates, highest NO_3 and NO_2 amounts in tomato leaves and fruits were obtained upon treatment with 36 kg N/ha. Similarly, in the 3rd and 4th reading, the highest value was obtained in the treatment T_8 with the value of 50.39 and 44.23 respectively. Treatment T_1 i.e. control constantly showed the lowest chlorophyll content in all the four readings. This may be due to lack of fertilizers addition in control as compared to other treatments. The application of organic and inorganic fertilizers increased the nutrient availability and soil microbial activity which resulting in more nutrient uptake. These results are in line with Abdul *et al*., (2013) who reported high N uptake with combined application of organic and inorganic fertilizers.

The mean value of chlorophyll content was found higher in treatment T_8 while the lowest value was noticed in treatment T_1 i.e. control. Closer analysis of Table 5 also shows that the chlorophyll content tends to increase initially in all the treatments but it showed the decreasing trend in most of the treatments as the crop is attaining the maturing.

Table 6 shows the correlation between SPAD reading and total nitrogen in soil. The coefficient of correlation was found 0.011 between these two parameters which indicates that there is positive but very low correlation between SPAD readings and total nitrogen in soil. The correlation was also non significant. The positive relation indicates that the change in SPAD meter reading directly affects the change in total nitrogen in soil. It also means higher the nitrogen content in the soil higher will be the uptake and higher will be the SPAD meter reading.

Table 6: Correlation between SPAD reading and total nitrogen in soil

Treatments	SPAD readings	Total soil nitrogen in soil
T_1	41.10	0.03
T_2	44.19	0.72
T_3	44.79	0.76
T_4	47.23	0.17
T_5	45.62	0.06
T_6	43.60	0.09
T_7	45.44	0.19
T_8	48.09	0.13
T_9	44.15	0.76
T_{10}	46.29	0.76
Correlation		
SPAD readings	1	**0.011**
Total N in soil	0.011	1

(Correlation is not significant)

4 Conclusion

Since, nitrogen highly affects on the growth and yield of the plant, it is a vital issue to be considered under nutrient management. From the statistical data obtained from the experimental research, highest yield was obtained from T_{10} (compost at 4%) i.e. 1.5kg followed by T_5 (1.289kg), T_7 (1.005kg) and T_6 (1.112kg). Based on the fruit yield, T_{10} can be considered as the best treatment for optimum nitrogen uptake. The research also showed higher chlorophyll content in leaves initially which decreased on maturity on most of the treatments. The correlation between SPAD reading and total nitrogen in soil after plant harvest was found statistically non-significant and least positively correlated. The correlation showed higher the nitrogen content in the soil higher will be the nitrogen uptake and higher will be the SPAD reading as well.

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