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Effect of nitrogen fertigation on yield and fruit quality of low chilling peaches under subtropical conditions of Himachal Pradesh

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ABSTRACT

Experiment was conducted to standardize the rate of nitrogen fertigation in peach under low hill conditions of Himachal Pradesh. Four N fertigation treatments were applied through drip to peach plants for two consecutive years during 2011 and 2012 and one recommended dose was added as soil application for control. The plants receiving higher (Full dose and 2/3rd dose) doses of N through fertigation were found to have significantly higher vegetative growth, fruit weight, fruit diameter and total yield as compared to lower rates (half and 1/3rd dose) of fertigation and soil application. Among the cultivars, Early Grande produced fruits with maximum weight (72.40 g) and length (46.76 mm), although the total yield was highest (25.22 kg/plant) in Partap owing to the higher number of fruits. The fertilizer use efficiency was highest (118.83 kg/plant/kg) in treatment T_4 (1/3 rd dose of N through drip).

Key words: Peach, fertigation, nitrogen, fruit quality, yield.

INTRODUCTION

Peach is one of the most important fruit crop grown in temperate climate of India. The fruit is ideally suited for areas experiencing 500 to 1,000 h of chilling during winter season but is widely grown under subtropical conditions due to availability of a large number of low chilling varieties. Peach is cultivated in India on an area of 36,409 ha accounting for 2,43,074 tonnes of production annually (FAO, 2). In Himachal Pradesh, the total area under peach is 5,181 ha, whereas annual production is 5,101 tonnes (http://hpagrisnet.gov.in, 5).

The productivity of peach in Himachal Pradesh is far behind the national figures in terms of area, production and productivity. Drip irrigation and fertigation is a suitable alternative for making judicious use of resources like water and fertilizers. N fertigation in general was found to increase total shoot extension by increasing the mean shoot length (Hipps, 4). Keeping in view the importance and future possibilities of its incorporation into the farming system of subtropical areas, an experiment was conducted to standardize nitrogen fertigation doses in some low chilling peaches.

MATERIALS AND METHODS

An experiment was conducted on the research farm of Institute of Biotechnology and Environmental Science, Neri during March to June 2011 and 2012 to standardize the dose of nitrogen fertigation in peach plants. The experimental site is situated in district Hamirpur, which falls in low hill region of Himachal Pradesh. The average mean maximum and minimum temperature is 31.3° and 12.4°C, respectively. The plant material comprised of six- year-old plants of three cultivars, *viz.* Partap, Prabhat and Early Grande. The plants were planted in contour terraces at a spacing of 3 m. The recommended dose for one-year-old was 70.0 g N. Using this dose, the required N fertilizer dose to be applied to the plants of 6 years (420 g) and 7 years (490 g) age was calculated. Urea having 46% N was used as a source of nitrogen for fertigation. Four nitrogen fertigation treatments, *viz.*, full dose recommended in package of practices, 2/3 dose, half, 1/3 dose of N were applied through drip to the peach plants in ten split application separated by an interval of 7 days. Fertigation treatments commenced from the last week of February just before flowering. A full dose of N was added as soil application as per standard recommendation to the control plants. Phosphorus and potassium were also applied as soil application as per standard practice. Fertigation was done through venturi. The observations were recorded on stem girth; shoot extension growth, tree spread and fruit set. The stem girth was measured at collar region of the plant before start of the experiment and at the end of the experiment. The tree spread was recorded in two directions, *i.e.*, N-S and E-W to assess the canopy expansion of the plants. Ten fruits were taken from each plant to assess the physico-chemical quality parameters such as fruit weight, length, diameter and total soluble solids. All the fruits harvested from each

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trees were weighed to deduce total yield per plant. The data generated from the present investigation were statistically analyzed employing randomized block design in accordance with procedure outlined by Gomez and Gomez (3).

RESULTS AND DISCUSSION

The data pertaining to increase in stem girth of plants as affected by fertigation treatments is presented in Table 1. The data clearly indicates that the effect of treatments on stem girth was non-significant. Among the cultivars, the highest increase in stem girth (1.39 cm) was recorded in the cultivar Early Grande followed by Partap and Prabhat. All the fertigation treatments enhanced stem girth over control, which had the least increase in stem girth. The difference between cultivars under study with respect stem girth was non-significant. There was a marked difference among treatments for shoot extension growth which was highest (172.5 cm) in treatment T_1 and was statistically at par with T_2 (152.8 cm). The cultivar Early Grande was observed to have the maximum (177.1 cm) followed by Parbhat (146.8 cm) and Partap (103.6 cm). The maximum tree spread in N-S (3.09 m) and E-W (3.21 m) direction was observed in the plants treated with full dose of NPK through drip (T_1), which was at par with treatment T_2 (2.98 m) in N-S direction, whereas it was significantly higher in E-W direction (2.97 m). The tree spread in other three treatments, *viz*. T3 (1/2 recommended dose), T4 (1/3 recommended dose through drip) and T5 (control) was statistically at par with each other although the lowest values were recorded in control. Among the cultivars, Early Grande was found to have minimum tree spread in both (2.78 m in N-S and 2.59 m in E-W) the directions. The results pertaining to growth parameters indicated that fertigation treatments were effective in enhancing vegetative growth in comparison to traditional method of fertilizer application. This might be attributed to the fact that there was a continuous supply of N in fertigation treatments meeting the requirement during critical periods of growth. Similar results have been obtained by Klein *et al.* (6) and Hipps (4). Fertigation has been reported to increase nutrients use efficiency by minimizing the leaching losses (Yosef, 12).

The data pertaining to yield and fruit quality of peach as affected by N fertigation is presented in Table 2. The highest fruit weight (61.92 g) was observed in the treatment T_1 (full dose of NPK through drip) which was statistically at par with treatment T_2 (58.11 g). The lowest fruit weight was recorded in treatment T_5 (control) which was at par with treatment T_3 (53.25 g) and T_4 (50.96 g). The cultivar Early Grande produced the fruit with maximum fruit weight

Table 1. Effect of nitrogen fertigation on growth and cropping in peach (pooled data for two years).

Fertigation rate	Increase in stem girth (cm)				Shoot extension growth (m)				Tree spread (N-S) (m)				Tree spread (E-W) (m)			
	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean
T_1 (Full dose through drip)	1.13	1.06	1.39	1.19	123.3	174.0	220.3	172.5	3.11	3.22	2.93	3.09	3.31	3.42	2.92	3.21
T_2 (2/3rd recommended dose through drip)	0.97	1.04	1.36	1.12	111.6	157.1	189.7	152.8	2.98	3.11	2.84	2.98	3.15	3.25	2.52	2.97
T_3 (1/2 recommended dose through drip)	0.98	0.97	1.32	1.09	95.6	144.3	176.2	138.7	2.79	3.01	2.78	2.86	3.03	3.04	2.50	2.86
T_4 (1/3rd recommended dose through drip)	0.92	0.91	1.24	1.02	92.2	132.5	152.4	125.7	2.73	2.90	2.71	2.78	3.04	2.90	2.49	2.81
T_5 (control) Full dose as soil application	0.90	0.92	1.20	1.00	88.6	126.4	147.3	120.7	2.70	2.93	2.64	2.76	2.98	2.91	2.51	2.80
Mean	0.98	0.98	1.30		103.6	146.8	177.1		2.86	3.03	2.78		3.10	3.10	2.59	
$CD_{0.05}$ Treatment (T)				NS				26.7				0.21				0.22
Variety (V)				0.16				21.3				0.19				0.31
T × V				NS				31.4				0.24				0.39

Table 2. Effect of nitrogen fertigation on yield and fruit quality in peach (pooled data for two years).

Fertigation rate	Fruit wt. (g)				Fruit length (mm)				Fruit dia. (mm)				TSS (°Brix)				Yield (kg/plant)			
	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean	V_1 Partap	V_2 Prabhat	V_3 Early Grande	Mean
T_1 (Full dose through drip)	62.72	44.40	78.64	61.92	47.98	43.24	51.52	47.58	50.34	42.28	50.30	47.64	11.33	14.85	13.32	13.16	28.49	26.89	25.15	26.84
T_2 (2/3rd recommended dose)	56.64	41.30	76.39	58.11	46.14	44.12	48.63	46.30	48.44	40.62	47.32	45.48	12.00	14.23	13.10	13.11	26.01	24.78	23.06	24.61
T_3 (1/2 recommended dose)	47.24	41.26	71.25	53.25	43.42	42.98	44.95	43.78	44.42	40.02	45.67	43.37	11.07	14.55	14.26	13.30	24.82	22.42	20.68	22.64
T_4 (1/3rd recommended dose)	42.02	39.62	67.25	50.96	44.88	41.56	45.14	43.86	46.26	39.11	42.66	42.68	12.73	13.96	13.14	13.50	23.51	21.25	19.37	21.37
T_5 (control) Full dose as soil application	45.80	38.61	68.47	50.96	43.21	40.16	43.61	42.32	45.48	37.66	40.83	41.32	12.63	13.62	14.24	13.49	23.54	21.29	19.45	21.42
Mean	51.68	41.03	72.40		45.12	42.41	46.76		46.98	39.93	45.32		11.95	14.24	13.60		25.27	23.32	21.54	
$CD_{0.05}$ Treatment (T)				6.72				3.59				3.04				NS				3.06
Variety (V)				8.41				2.09				1.81				1.22				2.52
T × V				12.34				4.33				3.92				NS				4.14

(72.40 g) and was significantly higher than 'Partap' (51.68 g) and 'Prabhat' (41.03 g). The interaction T × V was highest in $T_1 \times V_3$ (72.40 g) and lowest in $T_5 \times V_2$ (41.03 g). Fruit length was found to be maximum (47.58 cm) in treatment T_1, which was at par with (46.30 cm) treatment T_2. The treatments T3 (1/2 recommended dose through drip), T4 (1/3 recommended dose through drip) and T5 (control) had fruit length statistically at par with each other. Among cultivars, Early Grande produced fruits with maximum (46.76 cm) fruit length followed by Partap (45.12 cm) and Prabhat (42.41 cm). The maximum value for T × V interaction (50.30 cm) was noted in T1 × V3. Similar results were obtained for fruit diameter in which the maximum (47.64 cm) value was observed in treatment T1 followed by treatment T2 (47.32 cm) and the lowest in T5 (40.83 cm). The maximum fruit diameter among varieties was noted in Partap (46.98 cm) followed by Early Grande (45.32 cm) and Prabhat (39.93 cm).

There was no significant effect of N fertigation treatment on TSS content of the fruits, although there was a significant difference among cultivars. The highest TSS content was recorded in cultivar Parbhat (14.24°Brix) followed by Early Grande (13.60°Brix) and Partap (11.95°Brix). The first order interaction T × V was also found to be non-significant. The highest (26.84 kg/plant) total yield per plant was obtained in plant fertigated with highest dose of NPK (T_1). This yield was statistically at par with treatment T_2 (24.61 kg). The lowest (21.37 kg) yield per plant was observed in treatment T_4 (1/3rd of recommended dose) and was at par with treatment T_3 (22.64 kg per plant) and T_5 (21.42 kg per plant). The yield per plant among cultivars was highest in Partap (25.37 kg/plant) followed by Prabhat (23.32 kg/plant). Kumar and Ahmad (8) recorded the highest nut number (990 and 3083/ tree) when the almond trees were fertigated with the full recommended dose of N. The first order interaction T × V was highest (28.49) in treatment combination $T_1 \times V_1$. The highest fertigation level produced the maximum fruit size and weight. It seems that under fertigation uniform distribution of N and its confinement to root zone might have increased its uptake and enhanced synthesis of metabolites resulting increase in fruit size and yield. Furthermore, Bussi *et al*. (1) suggested that higher yield may be due to direct effect of nutrient fertilizing timing and reduction in nitrate leaching. Fertilizer use efficiency shows the yield of fruits per unit of fertilizer applied. The highest (118.83 kg/plant/kg) fertilizer use efficiency was found in the treatment T4 (1/3rd of recommended dose). In general, all the fertigation treatments increased fertilizer use efficiency over control, which had the least (39.70 kg/plant/kg) value for FUE (Table 3). Similar results were

Table 3. Fertilizer use efficiency under nitrogen fertigation treatments in peach.

Treatment	Fertilizer use efficiency (kg/ plant/ kg)		
	V_1 Partap	V_2 Prabhat	V_3 Early Grande
T_1 (Full dose through drip)	58.14	54.87	51.33
T_2 (2/3rd recommended dose)	79.78	76.01	70.74
T_3 (1/2 recommended dose)	101.31	91.51	84.41
T_4 (1/3rd recommended dose)	144.23	130.37	118.83
T_5 (control) full dose as soil application	48.04	43.45	39.70

obtained by Lord *et al.* (9), who reported high fertilizer use efficiency through fertigation. A reduction of N requirement by about 50% has also been reported by Michael *et al*. (10) when applied through drip.

It can be concluded that fertigation of peach plants @ 2/3rd of the recommended dose produced significantly higher total and quality of the fruits. Furthermore, the performance of plants under this treatment was at par with the plants fertigated at full recommended dose. Therefore, the dose of N application in peach can be reduced to 2/3rd of its standard rate when applied through drip without any significant reduction in yield and fruit quality.

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