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Influence of various sources and levels of fertilizer applied through fertigation on hybrid watermelon grown in *rabi*-summer

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ABSTRACT

A field experiment was conducted at Bangalore during 2006-2008 to study the effect of fertigation on growth and yield of *rabi*-summer grown watermelon. Seven treatments comprising varying rates and sources of fertilizers were applied. Application of water soluble fertilizer @ 70:70:70kg N:P_2O_5:K_2O per hectare through fertigation gave significantly higher vine length, number of branches per plant and leaf area index. In general, fertigation treatments recorded higher values for number of fruits per plant, fruit weight and total soluble solids than conventional soil-application of fertilizers. All the fertigation treatments recorded higher average marketable watermelon yield over conventional soil-application of fertilizers amounting to 7.22 to 26.4% increase. Among fertigation treatments, though recommended dose of fertilizer applied as water soluble fertilizer resulted in highest marketable-fruit yield, highest net income (Rs. 229775) and B:C ratio (3.03) was obtained in treatment with 70% of recommended dose of NPK using conventional fertilizers supplied through fertigation.

Key words: Watermelon, fertigation, *rabi*, summer, growth, yield, economics

INTRODUCTION

Watermelon [*Citrullus lanatus* (Thunb.) Matsum *et* Nakai] is believed to have originated in Africa and spread to other parts of world. Global area under watermelon cultivation is 37,52,568 ha with annual production of 99,194,223mt (Vasanth Kumar *et al*, 2012). It is a commercially important crop in India and the most popular among melons grown in summer. Watermelon comprises 90% water, therefore, water supply to the crop is very critical during growth and development of the plant and fruit. Water shortage causes noticeable gaps in production, with reduction in leaf area and overall yield. Supply of water throughout the growth period is important, but absolutely critical during flowering and fruit development. Drip fertigation is an important irrigation-cum-nutrient application method in crop production, particularly, in arid and semi-arid regions where there is a high competition for available water resources. Drip irrigation under plastic mulch is an effective way of supplying water efficiently in watermelon cultivation. This may reduce total water requirement besides increasing water use efficiency (Srinivas *et al*, 1989; Anon., 2002). To reduce cost of production and environmental pollution, judicious use of water and nutrients is very important. Micro-irrigation and fertigation are among the best option to help economize water and fertilization use in vegetable cultivation (Clothier *et al*, 1985) and for lowering leaching losses (Ristimaki, 1999). Scientific information on fertigation, especially in watermelon, is very scanty. Hence, the present field experiment was set up to determine influence of drip fertigation for supply of different fertilizer sources and levels on growth, fruit yield and quality in watermelon.

MATERIAL AND METHODS

The experiment was conducted during *rabi*-summer seasons of 2006-2007 and 2007-2008 at Indian Institute of Horticultural Research, Hesaraghatta, Bangalore. Soil at the experimental site was red sandy-loam, with organic carbon 0.53%, electrical conductivity 0.24 dS/m, neutral pH (6.72), low available N (160kg/ha), low available P (9.3kg/ha) and medium available K (138kg/ha). The soil had a capacity for holding 148mm available water in the top one meter of its profile. Seeds of watermelon hybrid NS-295 were sown in rows of 2m width, with 60cm plant-to-plant spacing, during the first week of November in both years. The experiment

Table 1. Treatments imposed in the experiment

Treatment			Symbol	Basal dose	Top-dressing	Fertigation
Level of fertilizer(kg/ha)	Fertilizer type	Application dose and method		(kg/ha)	(kg/ha)	(kg/ha)
Recommended dose (100:100:100 $N:P_2O_5:K_2O$)	Conventional	100% NPK soil application	T_1	50:100:50	50:0:50	0:0:0
	Conventional	50% NK fertigation	T_2	50:100:50	0	50:0:50
	WSF	100% NPK fertigation	T_3	0:0:0	0	100:100:100
70% of recommended dose (70:70:70 $N:P_2O_5:K_2O$)	Conventional	NK fertigation	T_4	0:70:0		70:0:70
	WSF	NK fertigation	T_5	0:70:0	0	70:0:70
	Conventional	NPK fertigation	T_6	0:0:0	0	70:70:70
	WSF	NPK fertigation	T_7	0:0:0	0	70:70:70

WSF: Water soluble fertilizer

Table 2. Source and quantity (kg/ha) of fertilizers applied under various treatments

Treatment	Basal dose			Top dressing		Fertigation					
	Urea	SSP	MOP	Urea	MOP	Urea	MOP	KNO_3	$Ca(NO_3)_2$	19:19:19	DAP
T_1	108.7	625	83.0	108.7	83.0	-	-	-	-	-	-
T_2	108.7	625	83.0	-	-	108.7	83.0	-	-	-	-
T_3	-	-	-	-	-	-	-	-	-	526.0	-
T_4	-	437.5	-	-	-	152.0	117.0	-	-	-	-
T_5	-	437.5	-	-	-	-	-	152.0	323	-	-
T_6	-	-	-	-	-	93.0	117.0	-	-	-	152.0
T_7	-	-	-	-	-	-	-	-	-	368.0	-

SSP - Single super phosphate; MOP- Muriate of potash; DAP - Diammonium phosphate;

Table 3. Meteorological data during crop growth period

Month	Temperature (°C)		RH (%)		Total	Evaporation	Wind
	Max.	Min.	Morning	Evening	rainfall(mm)	(mm)	speed(km/h)
November 2006	27.2	18.1	84.5	72.8	112.7	2.7	4.9
December 2006	26.6	14.7	80.0	72.6	-	3.7	5.6
January 2007	28.4	11.8	78.8	43.2	-	4.5	5.3
February 2007	29.9	12.9	58.6	29.6	-	5.6	5.5
March 2007	33.2	16.7	53.3	26.2	-	7.1	5.3
April 2007	33.8	19.7	68.9	36.8	53.4	5.5	6.7
November 2007	26.7	13.1	68.2	59.7	2.8	4.2	3.3
December 2007	27.5	11.4	74.2	65.1	-	5.2	3.8
January 2008	28.5	11.9	73.1	53.1	-	3.6	3.9
February 2008	29.7	15.7	60.6	37.0	7.4	4.7	4.5
March 2008	30.1	16.6	55.0	36.8	105.7	6.2	5.0
April 2008	31.8	18.5	62.6	38.8	11.1	4.1	4.9

was laid out in Randomized Block Design, with seven treatments and three replications. Uniform basal dose of farm yard manure @ 25t/ha was applied before sowing. Treatment details with source and amount of various fertilizers applied are given in Tables 1 and 2. Reflective mulch 30 micron thick and 1.2m wide was used. Conventional fertilizers used in the experiment were urea, single super phosphate, di-ammonium phosphate and muriate of potash; whereas, 19 each of N, P_2O_5, K_2O, KNO_3 and Ca $(NO_3)_2$ formed the source of water soluble fertilizer. Recommended dose of fertilizer in the present study comprised 100kg N, 100kg P_2O_5 and 100kg K_2O per hectare. Fertilizer was applied at weekly intervals through inline drippers in all the fertigation treatments. Soil treatments received the entire P_2O_5 and K_2O at sowing, and N in two splits-one at sowing, and the other 28 days later. Irrigation was based on evaporation replenishment (0.7 Epan) and imposed daily on all the treatments through inline drippers. Fertilizers were injected through non-electrical proportional injector at weekly intervals, starting with seven days after germination, and continued for upto 75 days after sowing at equal rates, as per treatments. Growth observations were taken 60 days after sowing. Meteorological data during crop growth period for both years is given in Table 3. All agronomic and plant protection measures were adopted as per recommended package of practices. The crop was harvested at 90 to 100 days after sowing, at fruit maturity as indicated by a dull sound of the fruit, or, when the fruit tendril turned to straw colour, or when the fruit base turned creamy-yellow in colour. Observations on crop growth, yield, yield parameters and quality were recorded and statistically analyzed as per Gomez and Gomez (1983).

RESULTS AND DISCUSSION

Growth parameters

All the treatments pertaining to fertigation (irrespective of source or dosage) resulted in better growth in terms of vine length, number of branches per plant and leaf area index compared to conventional soil-application during both years (Table 4). Among fertigation treatments, application of 100 and 70% recommended dose of NPK, in the form of water soluble fertilizer (T_3 and T_7), recorded significantly higher vine length than in N:K fertigation at 70% recommended dose (T_4 and T_5) in 2006-07 and than all the treatments in 2007-2008. Irrespective of dosage and combination of fertilizers in fertigation, vine length and number of branches per plant was higher in water soluble fertilizer treatment than with conventional fertilizers. Application at 100% recommended or 70% of recommended rate through fertigation produced significantly higher number of branches per plant compared to soil-application treatments. Leaf area index was highest in T_7 and lowest in T_4 and T_1 during 2006-07 and 2007-08, respectively. Improvement of crop growth and leaf area in watermelon has been reported to be better with nutrients supplied through fertigation rather than by soil application (Zhang, 2011).

Table 4. Growth of watermelon as influenced by fertigation treatments

Treatment	Vine length(cm)		No. of branches per plant		Leaf area index	
	06-07	07-08	06-07	07-08	06-07	07-08
T_1	242.3	255.0	8.2	8.0	2.52	2.50
T_2	281.1	273.0	9.3	8.3	2.54	2.52
T_3	286.6	330.0	10.8	10.0	2.58	2.61
T_4	235.3	286.0	10.7	8.6	2.49	2.55
T_5	246.8	300.0	10.7	10.8	2.60	2.63
T_6	277.3	305.0	10.9	9.8	2.56	2.62
T_7	303.2	346.0	11.4	11.0	2.63	2.66
CD ($P=0.05$)	25.49	20.74	1.40	1.41	0.09	0.0872

Yield and yield attributes

There were no significant differences among treatments for number of fruits per plant during 2006-07. But, in 2007-08, all water soluble fertilizer fertigation treatments (T_3, T_5 and T_7) recorded higher number of fruits per plant than any other treatment (Table 5). These treatments were also significantly superior to conventional fertilizer treatment of soil-application of 100 or 50% recommended dose (T_1 and T_2), and remained at par with 70% NPK application using conventional fertilizer. Significant differences for fruit weight due to different treatments were observed but, overall, higher fruit weight was observed in treatments receiving water-soluble fertilizers compared to treatments receiving conventional fertilizers. Application of 50% N:K fertigation (T_2) resulted in significantly higher fruit weight (4.89kg) which was at par with T_4 and T_6, and all these treatments were superior to soil-application treatments in 2006-07. During 2007-08, fruit weight was comparatively more in crops receiving water-soluble fertilizers through fertigation compared to all the treatments involving conventional fertilizers. Total soluble solids (^{o}Brix), representing fruit quality, did not differ significantly due to different fertigation treatments. However, T_7 (which received 70% recommended dose of water-soluble fertilizers) recorded highest values for TSS in both years. Battilani and Solimando (2006) and Andrade Junior *et al* (2009) also reported no significant differences in fruit quality in watermelon with various levels of fertilizers supplied through fertigation. All the fertigation treatments recorded higher yield over conventional method of applying commercial fertilizer as soil-application (T_1) for upto 7.23

Table 5. Effect of fertigation level on yield, yield attributes and quality in watermelon

Treatment	No. of fruits per plant		Fruit weight (kg)		TSS (^{o}Brix)		Yield (t/ha)	
	06-07	07-08	06-07	07-08	06-07	07-08	06-07	07-08
T_1	1.31	1.32	4.32	5.32	9.38	9.20	45.61	55.80
T_2	1.30	1.25	4.89	5.75	9.63	9.24	48.91	59.81
T_3	1.40	1.60	4.43	6.15	9.68	10.45	60.20	68.85
T_4	1.33	1.43	4.68	5.95	9.75	9.56	53.49	63.34
T_5	1.37	1.62	4.37	6.06	9.76	10.48	56.66	66.50
T_6	1.42	1.51	4.69	5.77	9.83	10.46	56.70	65.50
T_7	1.42	1.68	4.45	6.01	9.90	10.56	59.87	68.31
CD($P=0.05$)	NS	0.19	0.35	0.47	NS	NS	7.72	3.46

NS = Non-significant

Table 6. Economics of watermelon crop in relation to fertigation treatments

Treatment*	Average yield (t/ha)	Gross investment (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	B:C ratio
T_1	50.70	77585	253500	175915	2.26
T_2	54.36	77585	271800	194215	2.50
T_3	64.52	104125	322600	218475	2.09
T_4	58.41	75317	292050	216738	2.87
T_5	61.58	98066	307900	209834	2.14
T_6	61.10	75725	305500	229775	3.03
T_7	64.09	93920	320450	226530	2.41

Sale Price = Rs. 5.00/kg
*For details on treatments, refer Table 1and 2

to 32.00% increase in 2006-07 and 7.18 to 23.38% in 2007-08. Higher yield obtained with fertigation treatments may be because of better growth, higher photosynthetic-surface area coupled with better yield attributes such as number of fruits per plant and larger fruit size. Gonsalves *et al* (2011) reported leaf area index to have a positive effect on the number of fruits and on productivity in watermelon. Application of 100% NPK fertigation at recommended dose through water-soluble fertilizer (T_3) recorded maximum and significantly higher yield (60.20 and 68.85 t/ha) than T_1 and T_2, but remained at par with treatments where only 70% of the recommended dose of NK or NPK was applied as fertigation (except in T_4) in the second year. Among other fertigation treatments, application of 70% NPK recommended dose through water-soluble fertilizers (T_7) recorded the second highest yield, followed by T_6 in the first year, and T_5 in the second year. Use of fertilizer at 70% of recommended dose through fertigation clearly resulted in higher yield than 50% N:K fertigation + 50% soil application or complete soil-application of conventional fertilizers at recommended dosage. This also indicated that to realize yields equivalent to or higher than in soil application of the entire dose or by fertigating with half the recommended conventional fertilizer, it is possible to save 30% of fertilizer using water-soluble or conventional fertilizers, applied entirely through fertigation. Kadam *et al* (2009) also reported 20% saving in fertilizer using fertigation in watermelon.

Economics

Details on economics and benefit:cost ratio in watermelon hybrid NS 295 in relation to various fertigation treatments tested are presented in Table 6. Highest gross income (Rs. 3,22,600/ha) was obtained in the treatment where the entire quantity of water-soluble fertilizers at recommended dosage was given through fertigation (T_3), followed by T_7 which received 70% recommended dose of water-soluble fertilizers through fertigation. Lowest gross income (Rs.2,53,500/ha) was obtained by applying recommended dose of conventional fertilizer to soil (T_1). Though treatment T_3 resulted in highest gross income, it failed to earn highest net income owing to higher cost of the water-soluble fertilizers. As for net income, the best performance was that of the treatment where 70% recommended dose of NPK using conventional fertilizers was supplied to the crop through fertigation. This treatment also resulted in highest B:C ratio (3.03) by virtue of fetching higher yield and gross income, and incurring comparatively low gross investment.

From this study, it is evident that application of 70 or 100% recommended NPK, through fertigation using water-soluble fertilizers, results in higher yield in watermelon hybrid grown during *rabi*-summer season. However, from the point of view of economics, 70% N:P:K fertigation using conventional fertilizers is more profitable. Hence, it is concluded that for better performance and profitability from hybrid watermelon grown during *rabi*-summer, supply of 70% recommended dose of NPK through fertigation using conventional fertilizers, is appropriate.

REFERENCES

Andrade Junior, A.S., de Dias, N. da S. Figueiredo Junior, L.G.M. Ribeiro, V.Q. and Sampaio, D.B. 2009. Response of watermelon to nitrogen fertigation. *IRRIGA*, **14**:115-122

Anonymous. 2002. Commercial Vegetable Production Guide. Watermelon. Oregon State University, USA

Battilani, A. and Solimando, D. 2006. Yield, quality and nitrogen use efficiency of fertigated watermelon. *Acta Hort*., **700**:85-90

Clothier, B., Scotter, D. and Harper, E. 1985. Three dimensional infiltration and trickle irrigation. *Trans. Amer. Soc. Agri. Engrs*., **28**:497-501

Gomez, K.A. and Gomez, A.A. 1983. *Statistical Procedure for Agricultural Research*, Wiley-International Science Publication, New York, USA

Gonsalves, M.V.I. Pavani, L.C., Fillho, A.B.C. and Feltrim, A.L. 2011. Leaf area index and furit yield of seedless watermelon depending on spacing between plants and N and K applied by fertigation. *Cientifica Jaboticabal*, **39**:25-33

Kadam, U.S., Deshmukh, A.D., Ingle, P.M. and Manjarekar, R.G. 2009. Effect of irrigation scheduling and fertigation levels on growth and yield of watermelon (*Citrullus lanatus* Thunb.). *J. Maharashtra Agril.*

Univ., **34**:319-321

Ristimaki, L. 1999. Comparisons between different sources of phosphate applied directly to soil and via fertigation. *Proceedings - International Fertilizer Society*, **430**, pp. 16

Srinivas, K., Hegde, D.M. and Havanagi, G.V. 1989. Effect of nitrogen fertilization and plant population on plant water relations and yield of watermelon under drip and furrow irrigation. *Singapore J. Primary Industries*, **17**:79-86

Vasanth Kumar, Shirol, A.M., Ravindra Mulge, Thammaih, N. and Prasad Kumar. 2012. Genotype x environmental interaction in watermelon (*Citrullus lanatus* Thunb.) genotypes for yield and quality traits. *Karnataka J. Agril. Sci*., **25**:248-252

Zhang BaoDong. 2011. Effects of different fertilizers on yield and quality of watermelons under drip irrigation. *China Cucurbits and Vegetables*, **24**:17-19

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