yield of maize form the pig manure and municipal compost treated plots were on par and significantly superior to the rest of the plots which were on par.

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Balance sheet of nutrients in direct seeded rice as influenced by irrigation regimes

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Abstract : The influence of irrigation regimes on uptake and balance sheet of nutrients was studied by conducting field experiments during kharif and rabi seasons of 1997. The highest levels of soil available nitrogen, phosphorus and potassium as per balance sheet was recorded with irrigating 2.5 cm depth three days after disappearance of ponded water due to lower crop uptake. But the highest actual soil available nutrients was recorded with irrigating 5 cm depth one day after disappearance of ponded water except soil available potassium. The highest soil available potassium was recorded with irrigating 2.5 cm depth three days after disappearance of ponded water. The highest grain yield was recorded in plots received with irrigation to 5 cm depth one day after disappearance of ponded water. Similarly, the same irrigation regime recorded the highest net returns and benefit cost ratio. (*Key Words : Water, Balance Sheet, Direct Seeded Rice).*

Efficient use of nutrients is essential for better crop management. Water is one of the critical inputs and the largest single cost in crop production. Praveen Rao *et al.* (1993) reported that water is the primary factor influencing the efficient use of applied fertilizer nutrients, since it is directly involved in their solubilisation, absorption and translocation to plant parts. Irrigation water influences the availability of nutrients in soil at greater level. Such information in respect of direct seeded rice is scanty. Hence, field experiments were conducted to study the effect of water management practices on uptake, availability and balance of nutrients by direct seeded rice crop.

Materials and Methods

The study was conducted in the wet land farms of Tamil Nadu Agricultural University, Coimbatore during kharif (June'97-October '97) and rabi (September '97-January '98) seasons. The soil of the experimental field was clay loam with pH 7.6 and EC 0.5 dSm^{-1} and field capacity was 30 per cent. The bulk density was 1.33 g cc^{-1} with 1.5 cm day^{-1} as infiltration rate. The amount of rainfall received during kharif and rabi seasons was 249.4 and 514.5 mm respectively. The available status of N, P_2O_5 and K_2O was in the order 248, 15 and 550 kg ha^{-1} respectively. ASD 18 and IR 20 rice varieties were used for the study. The experiments were laid out in randomised block design with nine irrigation regimes. The treatments were replicated thrice. The irrigation regimes include,

1. Irrigation to 5 cm depth one day after disappearance of ponded water (I_1),

2. Irrigation to 5 cm depth three day after disappearance of ponded water (I_2),

3. Continuous submergence of 2.5 cm depth throughout the crop period (I_3),

4. Irrigation to 2.5 cm depth one day after disappearance of ponded water (I_4),

5. Irrigation to 2.5 cm depth three day after disappearance of ponded water (I_4),

6. Saturation throughout the crop period (I_6),

7. Maintaining 5 cm depth of water during critical stages and maintaining saturation during ordinary stages (I_7),

8. Maintaining 2.5 cm depth of water during critical stages and maintaining saturation during ordinary stages (I_8) and

9. Transplanted rice - Irrigation to 5 cm depth one day after disappearance of ponded water (I_9).

Here the critical stages include active tillering, panicle initiation and flowering. The direct sowing was carried out by drum seeder developed by Tamil Nadu Agricultural University, Coimbatore using pre-germinated seeds. In the investigation, no specific fertilizer treatments were included. The impact of irrigation regimes on soil available nutrients and crop uptake was alone studied.

Results and Discussion

Yield, water use and economics

Irrigation to 5 cm depth one day after disappearance of ponded water in direct seeded rice (I_1) recorded the highest grain yield of 55 q ha^{-1} during kharif '97. The same irrigation regime with transplanted rice (I_9) recorded the highest grain yield during rabi '97. However continuous submergence of 2.5 cm depth throughout the crop period was not significantly different from the above irrigation regime. In both the seasons, irrigating 2.5 cm depth three days after disappearance of ponded water (I_5) recorded the lowest grain yields because rice plants experienced moisture stress in this irrigation regime. The results are on line with the findings of Packiaraj and Venkatraman (1991). DMP and N uptake were also more with irrigating 5 cm depth one day after disappearance of ponded water (I_1).

The higher water use was recorded with transplanted rice-irrigating 5 cm depth one day after disappearance of ponded water (I_9) as more water was required for raising nursery and for extended land preparation. Bhuiyan *et al.* (1995) also reported more water requirement for transplanted rice when compared to direct seeded rice. This ultimately reduced the water use efficiency of transplanted rice. The highest water use efficiency was recorded with continuous submergence of 2.5 cm depth throughout the crop period (I_3) in both the seasons as it produced more grain yield with minimum quantity of water compared to I_1 and I_2.

The highest net returns of Rs. 17704/- and Rs. 20749/- ha^{-1} was recorded with irrigating 5 cm depth one day after disappearance of ponded water in direct seeded rice (I_1) and transplanted rice (I_9) respectively during kharif and rabi '97. Though transplanted rice produced higher net returns during rabi '97, the benefit: cost ratio was less compared to I_1 and I_3 due to the fact that transplanted rice required more labour for transplanting and more water than direct seeded rice (See Table 1 and 2).

Balance sheet of nutrients

Nitrogen

Irrigation to 2.5 cm depth three days after disappearance of ponded water (I_5) recorded the highest amount of nitrogen as per balance sheet. But the highest quantity of actual soil available nitrogen was recorded with irrigating 5 cm depth one day after disappearance of ponded water in both direct seeded (I_1) and transplanted rice (I_9). Continuous submergence of 2.5 cm depth throughout the crop period was also on par with this irrigation regime. The lowest soil available nitrogen was recorded with maintaining 2.5 cm depth of water during critical stages and maintaining saturation during rabi '97. Tyagi and Agarwal (1989) reported that nitrogen availability increase with continuous submergence over alternate wetting and drying. Biswas and Mahapatra (1980) reported that the concentration and uptake of nitrogen in rice crop were significantly influenced by waterlogging. The reason may be due to enhanced availability of nitrogen in this irrigation regime.

Patnaick and Mohanty (1985) opined that soil submergence decreased nitrate N and slightly increased nitrite N content and accumulation of ammonia possibly through de-amination. On drying, the accumulated ammonia increased the availability of nitrogen in the soil in higher water regimes.

Phosphorus

Irrigation to 2.5 cm depth three days after disappearance of ponded water (I_5) recorded the highest quantity of phosphorus availability as per balance sheet due to lower P uptake in this irrigation regime. But the highest quantity of actual soil available phosphorus was recorded with irrigating 5 cm depth one day after disappearance of ponded water (I_1) in both the seasons. Continuous submergence of 2.5 cm depth throughout the crop period (I_3) was not significantly different from the above irrigation regime. The lowest balance of phosphorus was recorded with saturation the crop period (I_6) in both kharif and rabi seasons.

Joshi and Sharma (1980) reported that soil availability of phosphorus is increased by flooding. Padhihar and Dikshit (1985) observed that the contents of phosphorus and iron in the rice crop is higher under flooded conditions rather than upland conditions. Iruthayaraj and Morachan (1980) indicated that under submerged conditions, conversion of insoluble phosphates into soluble form takes place thereby increasing the availability of P_2O_5 in the soil and uptake by the rice crop.

Potassium

The highest availability of potassium as per balance sheet was recorded with irrigating 2.5 cm depth three days after disappearance of ponded water (I_5) due to lower K_2O uptake by the rice crop. The highest quantity of actual soil available potassium was also recorded with the same irrigation regime in both the seasons. But this irrigation regime was not significantly different from many of the treatments. Jose Mathew and Sankaran (1993) reported that early flooding increased the potassium content and availability in the soil thereby increased the uptake. Yoshida (1981) opined that prolonged submergence increased the concentration of K_2O in the soil solution with a corresponding increase in the absorption.

Therefore, it may be concluded that irrigating 5 cm depth one day after disappearance of ponded water may be advocated for higher productivity, net returns and for higher uptake of nutrients. But under the present circumstance of water scarcity, continuous submergence of 2.5 cm depth will be beneficial. This irrigation regime also resulted in higher productivity, net returns and higher uptake when compared with higher irrigation regimes.

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Table 1. Grain yield and water use efficiency of direct seeded rice as influenced by irrigation regimes.

Treatments	Grain yield (Kg ha^{-1})		Total water applied (cm)		Water use efficiency (Kg ha-cm^{-1})		Net returns (Rs ha^{-1})		Benefit : Cost ratio	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
I_1	5505	5107	110	104	49.7	48.9	17704	20237	2.58	2.67
I_2	4952	4751	99	97	49.6	48.9	15117	18146	2.36	2.51
I_3	5283	5052	104	99	50.6	51.4	16658	19896	2.49	2.63
I_4	5060	4837	101	97	50.0	50.1	15589	19549	2.39	2.54
I_5	4342	4158	95	94	45.6	44.4	12136	14485	2.09	2.20
I_6	4471	4228	95	93	46.8	45.4	12723	14908	2.14	2.23
I_7	4756	4528	97	96	48.9	47.5	14406	16661	2.29	2.38
I_8	4655	4432	96	95	48.3	46.9	13615	16051	2.22	2.33
I_9	5428	5288	138	125	39.2	40.9	16445	20479	2.36	2.58
SE_d	77	88	-	-	-	-	-	-	-	-
CD (5%)	232	249	-	-	-	-	-	-	-	-

For treatment details, refer Materials and Methods.

Table 2. Balance sheet of nitrogen as influenced by irrigation regimes at harvest (kg ha^{-1})

Treatments	Initial Soil available nitrogen		Nitrogen added		Total nitrogen present in the soil		Nitrogen uptake		Balance		Actual soil available nitrogen	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
I_1	248	205	120	150	368	355	104.4	92.3	263.6	262.7	252.3	231.1
I_2	248	205	120	150	368	355	94.8	85.4	273.2	269.6	236.3	206.2
I_3	248	205	120	150	368	355	99.8	90.6	268.2	264.4	251.4	221.5
I_4	248	205	120	150	368	355	92.3	87.0	275.7	268.0	239.2	211.4
I_5	248	205	120	150	368	355	79.8	75.2	288.2	279.8	231.0	188.0
I_6	248	205	120	150	368	355	83.0	77.4	285.0	277.6	228.2	186.1
I_7	248	205	120	150	368	355	85.1	82.1	282.9	272.9	226.7	196.5
I_8	248	205	120	150	368	355	87.6	80.5	280.4	274.5	221.1	191.5
I_9	248	205	120	150	368	355	101.1	94.2	266.9	260.8	248.1	191.3
SE_d	-	-	-	-	-	-	1.5	1.4	-	-	3.3	3.2
CD (5%)	-	-	-	-	-	-	4.6	4.3	-	-	9.9	9.7

For treatment details, refer Materials and Methods.

Table 3. Balance sheet of phosphorus as influenced by irrigation regimes at harvest (kg ha^{-1})

Treatments	Initial soil available phosphorus		Added phosphorus		Total phosphorus present in the soil		Phosphorus uptake		Balance		Actual soil available phosphorus	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
I_1	15	16.2	38	50	53	66.2	19.7	18.1	33.3	48.1	23.3	33.3
I_2	15	16.2	38	50	53	66.2	16.2	15.5	36.8	50.7	20.2	25.3
I_3	15	16.2	38	50	53	66.2	18.4	17.5	34.6	48.7	22.5	29.9
I_4	15	16.2	38	50	53	66.2	16.2	16.0	36.8	50.2	20.6	31.3
I_5	15	16.2	38	50	53	66.2	12.3	11.1	40.7	55.1	21.1	30.4
I_6	15	16.2	38	50	53	66.2	13.2	12.2	29.8	54.0	18.2	28.2
I_7	15	16.2	38	50	53	66.2	15.0	14.3	38.0	51.9	19.4	27.9
I_8	15	16.2	38	50	53	66.2	16.4	13.7	38.6	52.5	19.0	26.9
I_9	15	16.2	38	50	53	66.2	18.9	18.8	34.1	47.4	22.9	28.5
SE_d	-	-	-	-	-	-	0.6	0.8	-	-	0.5	0.7
CD (5%)	-	-	-	-	-	-	1.8	2.7	-	-	1.6	2.2

For treatment details, refer Materials and Methods.

Table 3. Balance sheet of phosphorus as influenced by irrigation regimes at harvest (kg ha^{-1})

Treatments	Initial soil available potassium		Added Potassium		Total potassium present in the soil		Potassium uptake		Balance		Actual soil available potassium	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
I_1	550	574	38	50	588	624	131.5	100.9	456.5	523.1	438.7	491.3
I_2	550	574	38	50	588	624	119.0	90.7	469.0	533.3	441.1	502.1
I_3	550	574	38	50	588	624	126.4	98.6	461.6	525.4	426.3	512.1
I_4	550	574	38	50	588	624	121.3	93.2	466.7	530.8	433.7	497.5
I_5	550	574	38	50	588	624	104.9	78.4	483.1	545.6	447.1	510.2
I_6	550	574	38	50	588	624	107.9	81.5	480.1	542.5	443.9	508.9
I_7	550	574	38	50	588	624	114.4	86.1	473.6	537.9	436.8	501.3
I_8	550	574	38	50	588	624	112.3	83.6	475.7	540.4	423.1	509.7
I_9	550	574	38	50	588	624	128.9	103.5	459.1	520.5	418.6	499.3
SE_d	-	-	-	-	-	-	4.4	3.4	-	-	3.3	3.2
CD (5%)	-	-	-	-	-	-	13.3	10.0	-	-	9.9	9.6

For treatment details, refer Materials and Methods.

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Influence of biostimulants on yield and quality of tomato (*Lycopersicon esculentum* Mill.)

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Abstract : A field experiment was conducted in a sandy loam soil at Agricultural Research Station farm, Bhavanisagar, Tamil Nadu, during August - December 1999 to study the effect of biostimulants on yield and quality of tomato. Foliar sprays of different growth stimulants significantly influenced the yield and quality parameters of PKM 1 tomato. The highest yield response was obtained by foliar sprays of vipul 0.1 per cent EC (Triacontanol) at 300 ml ha^{-1} for three times at 25, 45 and 65 days after transplanting (36.0 t ha^{-1}). Besides this, fruit quality parameters were improved by this treatment. (*Key Words : Plant growth regulators, Tomato, Vipul, Fruit quality, Triacontanol*).

Tomato (*Lycopersicon esculentum* Mill.) is a common vegetable in the tropics and has attained worldwide importance because of its versatility in use in very many preparations. Special premium is being paid for good coloured fruits having high nutritive values. Plant growth regulators or biostimulants are known to control various physiological processes associated with growth and development of plants. Synthetic growth regulators produce their effects through changing the endogenous levels of the naturally occurring plant hormones resulting in improvement of yield and quality in the desired direction and to the desired extent. Triacontanol is one of the latest additions to growth regulators that are currently in use for enhanced productivity of crops. Hence the present investigation was aimed to study the influence of bioregulators developed by Indian Association of Plant Growth Products, Mumbai, on tomato crop.

Materials and Methods

A field experiment was conducted during August - December, 1999 at Agricultural Research Station farm, Bhavanisagar to study the effect of various plant growth regulators on yield and quality parameters of tomato fruit. The texture of the soil is sandy loam belonging to Irugur series (Typic Ustropept). Fertility status of the soil was low (208 kg ha^{-1}), medium (13.5 kg ha^{-1}) and medium (245 kg ha^{-1}) for N, P and K respectively. The treatments comprised of control (water spray), foliar sprays of vipul 0.1 per cent EC (at 200, 250 and 300 ml ha^{-1}), miraculan 0.05 per cent EC (at 200, 250 and 300 ml ha^{-1}) and planofix at 50 ppm which were given for three times and basal application of triacontanol granules 0.05 per cent (at 20, 25 and 30 kg ha^{-1}). The experiment was laid out in a randomized block design with three replications. The net plot size of experimental trial was 5m x 4m. Tomato cultivar PKM 1 was the test crop. The tomato seeds were line sown and transplanted in the main field 25 days after sowing by adopting a spacing of 60 cm x 45 cm. A uniform dose of 150:100:50 kg ha^{-1} of N, P and K was applied through urea, single super phosphate and muriate of potash. Besides that borax @ 10 kg ha^{-1} and zinc sulphate @ 50 kg ha^{-1} were also applied as basal dose. Routine cultural practices were followed. Foliar sprayings were given at 25, 45 and 65 days after transplanting and triacontanol granules were applied directly to the soil before transplanting of tomato seedlings. At maturity the