Madras Agric. J., 100 (7-9): 717-721, September 2013
https://doi.org/10.29321/MAJ.10.001390

Impact of Azophosmet and Humic Acid on Growth, Yield and Economics of Rice Under Drip Fertigation System

***R. Govindan[1] and T. Myrtle grace[2]**
Department of Agronomy, Agricultural College and Research Institute,
Madurai - 625 104, Tamil Nadu Agricultural University,

Field experiment was conducted at Central farm, Agricultural College and Research Institute, Madurai, during *Rabi* 2009 - 2010 to study the impact of azophosmet and humic acid on growth, yield and economics of rice under drip fertigation system. The experiment was laid out in factorial randomized block design with three replications. Two rice varieties were tested as first factor (V_1: PMK (R) 3, V_2: ARIZE 6444). In the second factor four management practices *viz.,* T_1 -Drip irrigation at 125 % PE +100% RDF through drip, T_2 -Drip irrigation at 150 % PE +100% RDF through drip, T_3-Drip irrigation at 125 % PE +100 % RDF through drip + azophosmet + Humic Acid (HA), T_4- Drip irrigation at 150 % PE + drip fertigation of 100 % RDF + azophosmet + humic acid. There was increase in rice root length and tillers per hill with drip irrigation at 150 per cent PE+ drip fertigation of 100 per cent RDF + azophosmet + humic acid which resulted in better crop growth, yield components and ultimately reflected on the grain yield, higher N, P, K uptake and economics. Drip irrigation at 150 per cent PE+ drip fertigation of 100 per cent RDF + azophosmet + humic acid recorded 19 per cent increased yield compared to drip irrigation at 125 per cent PE+100 per cent RDF through drip.

Key words: Rice, Drip fertigation, Root length, Tillers per hill, Azophosmet, Humic acid.

Rice (*Oryza sativa L.*) is one of the most important staple food crops in the world. In Asia, more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products. In India, rice occupies an area of 44 million hectare with an average production of 90 million tonnes with productivity of 2.0 tonnes per hectare. Demand for rice is growing every year and it is estimated that in 2025 AD the requirement would be 140 million tonnes. Water and nutrients are essential requirements for the crops to grow. Nutrients may be of organic or inorganic in nature. Inorganic fertilizers are costly and cause environmental problems. Use of organic fertilizers alone can not meet the nutritional requirement of the plant (Ahmad *et al.,* 1996). So, combined application of organic and inorganic fertilizers are required to maintain and increase the soil fertility as well as to increase the crop productivity.

Bioinoculants constitute an important component in integrated plant nutrient system. It is added advantage when these microbial inoculants are supplied through drip system (biofertigation) as it has more water use efficiency, fertilizer use efficiency and quality etc. Effective microorganisms can also be applied in the field along with organic or inorganic materials (Hussain *et al.,* 1999) . The organic and biological sources of nutrients provide essential nutrients to the crop and also enhance the positive interaction with chemical fertilizers by increasing their efficiency (Ahmad *et al.,* 1996).

Beneficial bacteria such as azospirillum, phosphobacteria and methylotroph colonizing in the rhizosphere region have the ability to fix nitrogen, solubilize phosphorus and stimulate plant growth. As an alternate to carrier based biofertilizer, liquid inoculant formulation with a good field performance that uses low cost materials and easily attainable by small producers could overcome many problems associated with processing solid carriers (Singleton *et al*., 2002).

Inoculation of liquid formulation of phosphate solubilizing *Bacillus megaterium* var. *phosphaticum* recorded higher root length, shoot length, cob yield in maize when compared to the carrier based phosphobacterial inoculant (Gomathy, 2003). The different humic acids had significant effect on nitrogen and phosphorus uptake by oats. The efficiency indices of various humic acids ranged between 25 and 65 per cent (Mishra and Srivastava, 1988). Raina and Goswami (1988) reported a significant increase in the uptake of N, P, Cu, Zn and Fe upto 20 ppm carbon as humic acid over control. With those ideas in review the present study was undertaken to evaluate the impact of azophosmet and humic acid on growth and yield of rice under drip fertigation system.

Material and Methods

An experiment was carried out during *rabi* 2009-2010 at Central farm, Agricultural College and Research Institute, Madurai, Tamil Nadu Agricultural

[1]*Corresponding author email: govindan.agr@gmail.com

University, Tamil Nadu, India, located in the southern agro climatic zone of Tamil Nadu, at 9°54' N latitude 78°54' E longitude and at an elevation of 147 m above mean sea level. The daily mean maximum and minimum temperatures during *rabi* were 31.6 and 21.8°C, respectively. The daily mean pan evaporation per day was 3.2 mm with relative humidity of 79.6 per cent during the season. During the cropping season, the crop received a total of 332.2 mm of rainfall. The soil of the study area was clayey with a pH of 7.4, available N, P, K status of 180, 10 and 312 kg ha^{-1} N, P and K respectively. The organic carbon content was 0.48 % and EC 0.42 dSm^{-1}.

Raised beds were formed manually with a top bed width of 70 cm and furrows were formed to a width of 30 cm and good tilth condition was made in the bed for easy sowing of seeds for early germination. Seeds were soaked in water for 12 hrs and shade dried for 12 hrs. The seeds were sown and covered in line over the raised bed at the spacing of 20 x 15 cm as direct spot seeding.

Drip irrigation schedule

First irrigation was given immediately after sowing and subsequent irrigations were scheduled once in three days based on the daily pan evaporation. Irrigation was given at 125 % PE and 150 % PE as per treatments. The quantity of water was calculated as follows.

$$\text{Volume } (l\ ha^{-1}) = PE \times Kp \times \text{Area } (m^2)$$

PE = Pan evaporation

K_p= Pan Factor (0.80)

Time of operation of drip system to deliver the required volume of water per plot was computed based on the formula

$$\text{Time of application} = \frac{\text{Volume of water required (l)}}{\text{Emitter discharge } (l\ ha^{-1}) \times \text{No. of emitters / plot}}$$

Fertigation

The fertilizer sources for supplying NPK through drip irrigation were urea (46 % N), urea phosphate (28:28:0 % NPK) and potassium nitrate (13:0:46 %NPK) and liquid bio fertilizer as azophosmet. Each plot consisted of one lateral for irrigating four rows of crops. The required quantity of N, P and K fertilizers as urea, urea phosphate and potassium nitrate as per the treatment were dissolved separately in water. Fertigation was done through fertigation tank once in six days starting from 15 DAS to 98 DAS, which was regulated by taps, provided near the take off points of the sub main.

The treatmental structure comprised of two factors *viz.,* two varieties and four drip fertigation treatments. The experiment was laid out in factorial randomized block design (FRBD) with three replications with a plot size of 24 m × 4 m. The treatments consisted of two varieties PMK (R) 3 and ARIZE 6444 along with drip irrigation at 125 % PE +100% RDF through drip, drip irrigation at 150 % PE +100% RDF through drip, drip irrigation at 125 % PE +100 % RDF through drip + azophosmet + humic acid (HA) and drip irrigation at 150 % PE +100 % RDF through drip + azophosmet + humic acid (HA). Control- Surface irrigation + soil application of recommended dose of fertilizers (RDF) (Maintained outside the experiment for comparison)

Irrigation was done once in three days based on pan evaporation, fertigation was given once in 6 days as per crop demand from 15DAS, azophosmet as seed treatment at 0.2 kg/5 kg seeds, soil application at 2.0 kg/ha (basal). Liquid biofertilizers at 500 ml/ha were given at panicle initiation and flag leaf stages. Humic acid was applied through drip fertigation at 500 ml/ha at panicle initiation and flag leaf stages two days after azophosmet application.

Results and Discussion

Plant growth parameters

Combination of microbial inoculum and chemical fertilizers given through drip irrigation has shown variable results. In general root characteristics in rice are strongly influenced by soil conditions and crop management practices (Thangaraj and Sivasubramanian, 1990). In the present study, ARIZE6444 (V_2) recorded constant increase in root length at all the stages. Similar results were expressed by Vijayakumar (2009) as higher root growth were recorded in drip irrigation treatment compared to conventional treatments in drip irrigated rice. ARIZE6444 (V_2) might have put forth deep and lengthy roots, which increased the root volume and mass of root proliferation at top. Root length increased significantly from maximum tillering to maturity stage. ARIZE6444 (V_2) showed higher root length under drip fertigation when compared to PMK(R) 3 (V_1) with the increased in 16 per cent at panicle initiation stage (Table 1)

Drip irrigation at 150 per cent PE + drip fertigation of 100 per cent RDF + azophosmet + humic acid registered higher root length as compared to drip irrigation at 125 per cent PE+ drip fertigation of 100 per cent RDF. The increased root length to the tune of 20.47 per cent under this treatment at panicle initiation stage might be due to the biofertigation with azophosmet and the availability of soil moisture which leads to the effective absorption of nutrients and better proliferation of roots. Root growth reduction under the irrigation regime at 125 per cent PE + drip fertigation of 100 per cent RDF was in proportion to the reduction in soil microbial status in tune with availability of nutrient inputs.

Number of tillers per hill

Variety ARIZE6444 (V_2) under drip irrigation at 150 per cent PE+ drip fertigation of 100 per cent RDF+ azophosmet + humic acid (V_2T_4) registered significantly higher number of tillers per hill at active tillering (28.5), panicle initiation (45.7) and maturity stages (32.0). This was followed by ARIZE6444 (V_2) with drip irrigation at 125 per cent PE + drip fertigation of 100 per cent RDF + azophosmet + humic acid (V_2T_3) which produced 26.6 (active tillering), 42.6 (panicle initiation) and 29.8 (maturity stages) tillers per hill (Table 2).

Dry matter production

Application of azophosmet and humic acid under drip fertigation system manifested significant influence on the DMP of rice at all the crop growth stages. The higher plant DMP was recorded in ARIZE6444 (V_2) at active tillering, panicle initiation and maturity stages (2991 kg ha^{-1}, 7479 and 12465 kg ha^{-1}, respectively). Drip irrigation of 150 per cent PE +drip fertigation of 100 per cent RDF + azophosmet + humic acid (T_4) registered significantly higher plant DMP than other treatments. The treatment (T_4) recorded higher plant DMP of 11538 kg ha^{-1} at maturity stage due to continues availability of soil moisture and higher nutrient uptake. This is in line with findings of Gomathy *et al*. (2008). Accumulation of higher DMP was noticed under Variety ARIZE6444 (V_2) along with drip irrigation at 150 per cent PE + drip fertigation of 100 per cent RDF + azophosmet+ humic acid (V_2T_4) 3282 kg ha^{-1}, 8205 kg ha^{-1} and 13676 kg ha^{-1} at active tillering, panicle initiation and maturity stages respectively (Table 3). The nutrient was distributed equally in the plant system which may be resulted in higher dry matter production.

Table 1. Influence of bio fertigation on root length (cm) of rice under drip fertigation system.

Stage	Active tillering stage			Panicle initiation stage			Maturity stage		
Treatment	PMK (R) 3	ARIZE 6444	Mean	PMK (R) 3	ARIZE 6444	Mean	PMK (R) 3	ARIZE 6444	Mean
T_1	19.2	21.4	20.3	24.1	26.7	25.4	26.5	29.4	28.0
T_2	20.1	22.7	21.4	25.1	28.4	26.7	27.6	31.2	29.4
T_3	20.9	24.4	22.6	26.1	30.5	28.3	28.7	33.5	31.1
T_4	22.0	27.0	24.5	27.5	33.7	30.6	30.3	37.1	33.7
Mean	20.6	23.9		25.7	29.8		28.3	32.8	
	V	T	V x T	V	T	V x T	V	T	V x T
SEd	0.8	0.9	1.1	1.1	1.2	1.2	1.2	1.3	1.3
CD(P=0.05)	1.8	2.0	2.2	2.1	2.3	2.4	2.4	2.7	2.8

Table 2. Influence of bio fertigation on number of tillers per hill of rice under drip fertigation system.

Stage	Active tillering stage			Panicle initiation stage			Maturity stage		
Treatment	PMK (R) 3	ARIZE 6444	Mean	PMK (R) 3	ARIZE 6444	Mean	PMK (R) 3	ARIZE 6444	Mean
T_1	20.4	24.2	22.3	30.5	38.7	34.6	24.4	27.1	25.8
T_2	21.4	25.4	23.4	32.1	40.6	36.3	25.7	28.4	27.0
T_3	23.1	26.6	24.9	34.7	42.6	38.6	27.8	29.8	28.8
T_4	24.4	28.5	26.5	36.1	45.7	40.9	29.3	32.0	30.4
Mean	23.0	26.8		34.0	42.8		27.3	30.0	
	V	T	V x T	V	T	V x T	V	T	V x T
SEd	0.7	0.7	0.7	1.0	1.2	1.1	0.6	0.8	0.8
CD(P=0.05)	1.6	1.7	1.7	2.3	2.8	2.6	1.5	1.9	1.7

Yield

Drip irrigation at 150 per cent PE + drip fertigation of 100 per cent RDF+ azophosmet+ humic acid (T_4) recorded significantly higher grain yield (4986 kg ha^{-1}). Drip irrigation at 125 per cent PE+ drip fertigation of 100 per cent RDF (T_1) recorded lower grain yield of 4188 kg ha^{-1}. Drip irrigation at 150 per cent PE+ drip fertigation of 100 per cent RDF + azophosmet + humic acid recorded 19 per cent increased yield compared to drip irrigation at 125 per cent PE+100 per cent RDF through drip. The increase in rice grain yield with

Table 3. Influence of biofertigation on dry matter production kg /ha of raised bed rice under drip fertigation system

Stage	Active tillering stage			Panicle initiation stage			Maturity stage		
Treatment	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1	2017	2658	2338	5043	6646	5845	8406	11077	9741
T_2	2095	2903	2499	4680	7257	5969	8729	12096	10412
T_3	2156	3123	2640	5390	7807	6599	8983	13013	10998
T_4	2255	3282	2769	5639	8205	6923	9399	13676	11538
Mean	2131	2991		5188	7479		8879	12465	
	V	T	V x T	V	T	V x T	V	T	V x T
SEd	102	144	115	246	379	321	443	599	547
CD(P=0.05)	208	311	252	532	784	664	854	1125	1054

Table 4. Influence of bio fertigation on yield and straw yield (kg ha-1) rice under drip fertigation system.

Treatment	Straw yield (kg/ha)			Grain yield (kg/ha)		
	PMK (R) 3	ARIZE 6444	Mean	PMK (R) 3	ARIZE 6444	Mean
T_1	4818	6287	5553	3588	4789	4188
T_2	4935	6839	5888	3793	5256	4525
T_3	5180	7326	6253	3803	5686	4745
T_4	5402	7701	6552	3997	5975	4986
Mean	5084	7038		3795	5426	
	V	T	V x T	V	T	V x T
SEd	269	342	291	193	272	236
CD(P=0.05)	596	754	635	403	607	511

drip irrigation at 150 per cent PE+ drip fertigation of 100 per cent RDF + azophosmet + humic acid was mainly attributed by greater and consistent availability of soil moisture and nutrient uptake which resulted in better crop growth, yield components and ultimately reflected on the grain yield. The lesser grain and straw yields obtained under drip irrigation at 125 per cent PE+ 100 per cent RDF through DF (T_1) might be due to lesser growth and yield attributes due to lack of adequate soil moisture (Table 4).

Microbial population:

Drip irrigation regimes at 150 per cent PE + drip fertigation of 100 per cent RDF+ azophosmet+ humic acid had significant influence on microbial population in the rhizosphere soil of rice during tillering, panicle initiation and harvest stages. Among the fertigation treatments the highest microbial population was registered in T_4 at tillering, panicle initiation and harvest stage (Table 5)

Nutrient Uptake

Azophosmet and humic acid application under drip irrigation registered higher N, P and K uptake compared to conventional irrigation of rice. Drip irrigation regime at 150 per cent PE+ drip fertigation of 100 per cent RDF + azophosmet + humic acid (T_4) registered higher nitrogen uptake of 117.5 kg N ha-1 than the other treatments. Drip irrigation at 150 per cent PE+ drip fertigation of 100 per cent RDF + azophosmet + humic acid (T_4) recorded higher P uptake (39.8 kg ha-1). Phosphorus uptake was lower in drip irrigation regimes at 125 per cent PE + drip fertigation of 100 per cent RDF (T_1) (34.0 kg ha -1). Similar result was reported by Tisdale *et al.* (1997) who reported that improved root growth of rice in the presence of HA would have induced large uptake of nutrients. Between varieties, ARIZE 6444 (V_2) recorded higher N, P and K uptake than PMK(R) 3. Regarding irrigation regimes drip irrigation regimes at 150 per cent PE + drip fertigation of 100 per cent RDF+ azophosmet+ humic acid (T_4) registered higher K uptake (chk the data kg ha-1) compared to drip irrigation regimes at 125 per cent PE + drip fertigation of 100 per cent RDF (T_1) (chk the data kg ha1) (Table 6).

Table 5. Influence of bio fertigation on microbial population (X 10^4 CFU g-1) of rice under drip fertigation system.

Treatment	Azospirillum Active tillering stage	Azospirillum Panicle initiation stage	Azospirillum Maturity stage	Phosphobacteria Active tillering stage	Phosphobacteria Panicle initiation stage	Phosphobacteria Maturity stage	PPFM Active tillering stage	PPFM Panicle initiation stage	PPFM Maturity stage
T1	11	14	17	12	15	17	10	13	16
T2	13	15	18	14	16	18	14	15	16
T3	19	20	22	17	19	21	18	20	22
T4	21	23	25	18	22	25	19	21	23
Mean	16	18	21	15	18	20	15	17	19
SEd	0.5	0.6	0.7	0.5	0.6	0.7	0.5	0.6	0.7
CD(P=0.05)	1.1	1.4	1.6	1.2	1.4	1.5	1.0	1.3	1.5

Table 6. Influence of bio fertigation on nutrient uptake (kg ha1) of rice under drip fertigation system

Treatments	Nitrogen	Phosphorus	Potassium
Varieties			
PMK (R) 3	109.6	35.6	85.0
ARIZE 6444	112.6	37.5	87.7
SEd	4.1	1.1	3.5
CD(P=0.05)	8.4	2.6	7.3
Treatments			
T1	105.4	34.0	34.0
T2	108.7	34.9	34.0
T3	112.8	37.5	37.5
T4	117.5	39.8	39.8
Mean	111.1	36.5	36.5
SEd	4.3	1.2	1.2
CD(P=0.05)	9.4	2.5	2.6

Economics

Among the treatments, ARIZE6444 (V_2) +drip irrigation at 150 per cent PE with drip fertigation of 100 per cent RDF +azophosmet + humic acid (V_2T_4) resulted in higher net return of Rs. 36891 ha-1. PMK(R) 3 (V_1) +drip irrigation at 125 per cent PE with drip fertigation of 100 per cent RDF (V_1T_1) resulted in lesser net returns (Rs. 15152 ha-1). The benefit cost ratio also followed the same trend as that of net returns. Higher B: C ratio of 2.1was observed in the treatment ARIZE6444 (V_2) +drip irrigation at 150 per cent PE with drip fertigation of 100 per cent RDF +azophosmet + humic acid (V_2T_4). Variety PMK(R) 3 (V_1) +drip

Table 7. Influence of bio fertigation on economics of rice under drip fertigation system

Treatment	PMK (R) 3				ARIZE 6444			
	Cost of cultivation (Rs ha1)	Gross return (Rs ha1)	Net return (Rs ha1)	B:C ratio	Cost of cultivation (Rs ha1)	Gross return (Rs ha1)	Net return (Rs ha1)	B:C ratio
T_1	27082	42234	15152	1.6	32201	55752	23552	1.7
T_2	27082	44555	17473	1.6	32201	61111	28910	1.9
T_3	27372	44660	17288	1.6	32491	66021	33530	2.0
T_4	27372	46840	19468	1.7	32491	69381	36891	2.1

irrigation at 125 per cent PE with drip fertigation of 100 per cent RDF (V_1T_1) resulted in lesser B: C ratio of 1.6 (Table 7).

From the above study, it can be concluded that separate application of fertilizers was found to increase the yield of rice over the control, their combined application of azophosmet and humic acid along with inorganic fertilizer further increased the yield when compared to sole application of inorganic fertilizers which suggested that a balanced fertigation is required for optimum growth and yield of rice.

References

Ahmad, N., Rashid, M. and Vaes, A.G. 1996. Fertilizer and their use in Pakistan NFDC Publication No. 4/96 Planning commission NFDC Islamabad Pakistan: 142-175.

Gomathy, M. 2003. Studies on development, standardization and evaluation of liquid formulation of phosphobacteria inoculant. M.Sc. (Ag.)., Thesis, Tamil Nadu Agricultural University, Coimbatore. 86. p.

Gomathy, M., Sathiya Prakash, D., Thangaraju, M., Sundaram, S.P. and Manika Sundaram, P. 2008. Impact of biofertigation of azophosmet on cotton yield under drip irrigation. *Res. J. Agric. Biol. Sciences*, **4:** 695-699.

Hussain, T., Javaid, T., Parr, J.F., Jilani, G. and Haq, M.A. 1999. Rice and wheat production in Pakistan with effective microorganism. *Am. J. Alt. Agri*., **14:** 30-36.

Mishra, B. and Srivastava, L.L. 1988. Physiological properties of humic acids isolated from some major soil associations of Bihar. *J. Indian Soc. Soil Sci.,* **36:** 83-89.

Raina, J.N. and Goswami, K.P. 1988. Effect of fulvic acid and fulvates on the growth and nutrient uptake by maize plant. *J. Indian Soc. Soil Sci.,* **36:** 264-268.

Singleton, P.W., Keyser, H.H. and Sande, E.S. 2002. Development and evaluation of liquid inoculants. **In**: Inoculants and nitrogen fixation of legumes in Vietnam. (ed., D. Herridge) ACIAR Proceedings, **109:** 52-66

Thangaraj, M. and Sivasubramanian, V. 1990. Physiological response of rice to water stress at reproductive phase. *Oryza*, **27:** 493-495.

Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J.L. 1997. Soil fertility and fertilizers (5th ed.) Prentice-Hall of India. Ltd., New Delhi.

Vijayakumar, P. 2009. Optimization of water and nutrient requirement for yield maximization in hybrid rice under drip fertigation system rice (*Oryza sativa* L). M.Sc. (Ag.)., Thesis, *Tamil Nadu Agric. Univ.,* Coimbatore.

Received:March 18, 2013; Accepted: August 4, 2013