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# Effect of different chemicals on production and productivity of rice (Oryza *sativa L.*) in navarai season

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**ABSTRACT**

***Two years of field experiments were conducted to study the effect of different chemicals as a foliar application at 15 DAT and 30 DAT on growth and yield of paddy (variety paiyur-1) under irrigated condition in North Western Zone of Tamil Nadu during navarai season. Among the chemicals, foliar application of 0.5 per cent zinc sulphate at 15 and 30 DAT has recorded the maximum plant height (cm) and no. of tillers followed by uniconozole @ 50 ppm in this study. The yield attributing parameters viz., no of productive tillers, no. of panicles per $m^2$, panicle length (cm), grain and straw yield (kg $ha^{-1}$) were found to be higher due to foliar application of 0.5 per cent zinc sulphate at 15 and 30 DAT. The maximum mean grain yield of 6810 kg ha-$^1$ with B C ratio of 2.69 was recorded for foliar application of 0.5 per cent zinc sulphate applied at 15 and 30 DAT and also increased the yield to the tune 37 per cent higher than control (4982 kg ha-$^1$)***

***Key words: Paddy, cold weather, chemicals, yield***

## I. INTRODUCTION

Rice is a seasonal crop and its growth and development will be affected by low temperature during winter season. It can be grown in different environments depending upon water availability and temperature conditions Cold stress is a common problem in rice cultivation and affects global production. Exposure to low temperature during cold condition affects all phonological stages of rice and lowers the grain yield production. Low temperature in vegetative stage can cause slow growth and reduce seedling vigor, low number of seedlings, reduced tillering (Shimono *et al.,* (2002). Cold stress affects paddy crop at seedling stage, leading to poor seedling establishment, which accounts for productivity losses. Germination and seedling establishment are sensitive growth stages for several crops particularly for paddy. Lower temperature during seedling establishment (October - December) significantly reduces seedling growth and establishment (Humphreys *et al.* 1996). In the North Western Agroclimatic Zone of Tamil Nadu like Krishnagiri Dt., Paddy is being cultivated in different seasons viz., Kuruvai / Samba (June – October) and navarai / winter (December – April) seasons. The yield of same paddy variety varies during navarai (winter season) and samba seasons which may be due to different climatic condition. Rice plants grown at normal temperature had significantly higher growth rate in contrast to plants grown at low temperature which showed growth depression as indicated by reduced plant growth and dry weight (Ahaeer *et al*., 2011).It has been reported that chlorophyll *a* and *b* content was decreased in plants when plants were subjected to cold treatment Low temperature in the range of 15–19$^o$ C had caused significant reduction in the number of panicles, the length of panicle, the number of filled grains, unfilled grains, total grains and yield of rice (Stake, 1976). Yield loss due to low temperature at high latitude and altitude areas were well documented in different countries (Lee, 2001). The occurrence of low temperature stress during the early growth stages of rice inhibits seedling establishment and eventually leads to non uniform crop

 

maturation and hence the good cold tolerance at the seedling stage is an important character for stable rice production (Lou *et al*., 2007)**.**
Hence, the knowledge on influence of weather parameters on crop parameters at seedling stage (because cold factors co –incide with stage) during navarai season is essential.

## II. MATERIALS AND METHODS

The experimental trial was conducted at Regional Research Station (TNAU) during navarai seasons (Dec. 2012 - May 2013) and (Dec.2013 – May 2014) under irrigated condition in paddy (variety - paiyur - 1). An experiment was laid out in a Randomized block design (RBD) consist of eight treatments viz, $T_1$ - Salicylic acid (100 ppm), $T_2$ - Calcium ammonium nitrate (0.5%),$T_3$ - Potassium chloride (0.5%) $T_4$ - Uniconazole (50 ppm), $T_5$ - Silicic acid (0.1%), $T_6$ -- Ascorbic acid (100 ppm) , $T_7$ - Zinc Sulphate (0.5 %) and $T_8$ - Control (without any chemical spray) with three replications. The crop was cultivated under SRI method with 15 days old seedlings. The spacing adopted was 22.5 x 22.5 cm. The manures and fertilizers were applied as per the recommendation (150:50:50 kg NPK $ha^{-1}$). The treatments were given as foliar spray twice at 15 days intervals during the severe cold weather condition (Dec to January) in the initial 30 days of the crop (seedling stage) in the main field. Accordingly, the chemical treatments were imposed as two foliar applications at 15 DAT and 30 DAT. The data were subjected to statistical analysis using AGRES.

The growth and yield attributing parameters were recorded at harvesting stage. The economic parameters like net return and benefit ratio were worked out by using prevailing market price of inputs and outputs.

## III. RESULTS

### Yield parameters

The yield parameters viz., no. of productive tillers, panicle/$m^2$, panicle length, panicle weight and unfilled grains/panicle have been varied at maturity stage due to application of different chemicals as a foliar application at 15 DAT and 30 DAT

Yield parameter data (Table -1) revealed that among the chemicals, the maximum plant height (127.27 cm) was found in zinc sulphate applied at 0.5 % concentration at 15 DAT and 30 DAT and it was on par with 50 ppm of uniconozole (124.48 cm) during navarai 2012-13. Again, the foliar application of 0.5 per cent zinc sulphate at 15 DAT and 30 DAT has shown maximum plant height (147.33 cm) at maturity stage of the crop, which was followed by 50 ppm of uniconozole (142.13 cm) during second year (2013-14). The control (no chemical foliar spray) recorded the comparatively lowest plant height in the both the years. The result is accordance with Tanmoykarak *et al*. (2006) and stated that zinc is one of the most essential micronutrients required for plant growth and development and yield of most crops, especially for rice grown in lowland conditions

The result has shown the remarkable variation in yield attributes, in case of the total no. of productive tillers per plant was significantly higher (26.9) by the application of 0.5 per cent zinc sulphate at 15 DAT and 30 DAT and it was as par with 50 ppm of uniconozole (24.6 tillers per plant) and the control (without any chemical application) recorded the 13.6 tillers per plant in the first year. But in the second year (Navarai 2013-14), the total no. of tillers per plant was 25.23 tillers per plant by the application of 0.5 per cent zinc sulphate at 15 DAT and 30 DAT. The better availability of zinc nutrient and proper absorption of nutrient were responsible for increased the yield growth parameters and development which ultimately brought higher yield .This might be owing to role of zinc nutrient for physiological improvement of the plant and thereby higher number of productive tillers and better plant growth and development.

 

In case the number of panicles per $m^2$ at the maturity stage of the crop, the number panicle was higher (490.2) by application of 0.5 per cent zinc sulphate at 15 DAT and 30 DAT than control (without any chemical application) with 460.3 panicles per $m^2$. The panicle length was found to be maximum (26.57cm) in zinc sulphate (0.5%) application as foliar application in plots and uniconozole (50 ppm) registered the panicle length of 25.22 cm. The number of grains / panicle was found to be highest (317.47) with application of zinc sulphate at 0.5 percent at 15 DAT and 30 DAT. Foliar application of Zinc and Iron was effective to improve rice growth and subsequently main yield components such as filled grains per panicle, panicle weight and 1000 grain weight

The same trend was observed in second year navarai (2013 -14). The panicle weight was found to be maximum with application of zinc sulphate @ 0.5 percent at 15 DAT and 30 DAT followed by foliar application of 50 ppm of uniconozole when compared to other chemicals and without any chemical ( control). The yield attributes in 0.5 per cent zinc sulphate applied plants has indicated the significant difference with respect to number of panicles per $m^2$ and no. of grains per panicle.

The total unfilled grains/panicle was found to be maximum in control (without any chemical application) whereas it was found to be less (16.67) in 0.5 per cent of zinc sulphate applied as foliar application. Maximum filled grains per panicle (140.40) and 1000-grain weight (25.88 g) belonged to mixed application of Fe+Zn+Si followed by Zn +Si ( Kassab, 2004).

**Yield**

The result (Table -2) showed that the grain and straw yields were significantly influenced by the chemicals. The highest grain yield (6979 kg $ha^{-1}$) obtained with the foliar application of zinc sulphate @ 0.5 % at 15 DAT and 30 DAT followed by Uniconazole (50 ppm) with yield of 6,839 kg $ha^{-1}$ and also increased the grain yield by 20.32% over the control (no chemical application). The effect of different sources of chemicals on the straw yield was the same trend as that of the grain yield. The maximum straw yield ( was obtained in the experiment consist of foliar application of 0.5 % of zinc sulphate at 15 DAT and 30 DAT. Application of zinc sulphate (0.5 %) at 15 and 30 DAT recorded to the tune of 49 per cent of increased grain yield over control (without any chemical application) during first year navarai (2012-13). In the navarai second year (2013-14), the highest grain yield (6642 kg $ha^{-1}$) obtained with the foliar application of Zinc Sulphate (0.5 %) followed by Uniconazole (50 ppm) with yield of 6328 kg $ha^{-1}$. The effect of 0.5 per cent foliar application in paddy at 15 and 30 DAT (seedling stage) recorded higher growth parameters, yield attributes, leading to the mean increase in grain yield by 37 per cent over control. Gurmani, (1988) stated application of Zn alone and combined of Mn and Cu has increased the yield components and yield of the rice significantly over 15 and 10% over control.

**Economics**

Economic analysis of data (Table-3) showed that 0.5 per cent of zinc sulphate at 15 DAT and 30 DAT was more effective than other chemicals for rice in realizing higher net returns and benefit: cost ratio

With regard to economics, 0.5 per cent of zinc sulphate at 15 DAT and 30 DAT recorded the higher net income of Rs. 70,707/- with the B: C ratio of 3.09 (Table -3). This was followed by 50 ppm of uniconozole on 15 DAT and 30 DAT, it recorded the gross income of Rs. 102584 /- , net income of Rs. 68616/- with the B:C ratio of 3.02.The lower gross income of Rs. 73466/- , net income of Rs. 41050 /- with the B:C ratio of 2.21 were recorded in control (without chemical application ).The highest net income (Rs 48295 $ha^{-1}$) and BC ratio (2.29) was obtained with the application of zinc sulphate (0.5 %) as foliar application at 15 and 30 DAT. The next best was uniconazole (50 ppm) with net income (Rs. 44641) with BC ratio of 2.19. The control (no

application) registered lesser income and BC ratio compared with chemical application. Hence, it is adviceable for application of zinc sulphate (0.5 %) to the low land irrigated paddy during navarai may be viable and effectively increase the cost benefit cost ratio. Foliar application of zinc sulphate fetched highest net return and B:C ratio during both the years and also reported by Ahaeer *et al*., (2011).

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**Table -1: Effect of chemicals on yield parameter of paddy at maturity stage during navarai season (2012-13 and 2013-14)**

| S.No | Plant height (cm) | | Productive tillers/hill (No.) | | No of panicle/$m^2$ | | Panicle length (cm) | | Panicle weight (g) | | Unfilled grains panicle | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
| $T_1$ | 122.99 | 136.32 | 25.00 | 22.65 | 470.70 | 465.23 | 24.26 | 23.10 | 1.96 | 2.19 | 32.67 | 42.60 |
| $T_2$ | 121.35 | 137.34 | 23.40 | 23.44 | 465.34 | 462.44 | 24.48 | 22.47 | 1.99 | 2.10 | 25.13 | 41.13 |
| $T_3$ | 120.50 | 129.04 | 19.70 | 20.92 | 457.30 | 455.34 | 24.26 | 22.29 | 1.94 | 1.96 | 25.60 | 40.77 |
| $T_4$ | 124.48 | 142.13 | 24.60 | 24.14 | 483.20 | 475.25 | 25.22 | 24.41 | 2.32 | 2.11 | 26.53 | 42.63 |
| $T_5$ | 119.49 | 127.17 | 23.40 | 23.43 | 468.00 | 465.15 | 23.91 | 24.16 | 1.97 | 2.16 | 24.47 | 46.22 |
| $T_6$ | 119.41 | 133.75 | 22.80 | 23.13 | 469.60 | 464.64 | 23.98 | 20.76 | 1.89 | 2.35 | 31.00 | 43.89 |
| $T_7$ | 127.27 | 147.34 | 26.90 | 25.23 | 490.20 | 491.31 | 26.57 | 24.52 | 2.47 | 2.67 | 16.67 | 39.04 |
| $T_8$ | 116.93 | 123.29 | 13.60 | 19.62 | 460.30 | 459.32 | 22.61 | 20.15 | 1.65 | 1.89 | 44.67 | 53.54 |
| SEd | 3.33 | 2.85 | 1.22 | 0.39 | 21.5 | 17.13 | 2.32 | 2.5 | 0.07 | - | 3.91 | - |
| CD (0.05 %) | 7.2 | 6.22 | 2.49 | 0.86 | 43.34 | 32.21 | 5.91 | 4.34 | 0.29 | NS | 8.53 | NS |

 

**Table -2: Effect of chemicals on yield attributes of paddy at maturity stage during navarai season (2012-13 and 2013-14)**

| | No. of Productive tillers/hill | | Filled grains/ Panicle | | Test weight (g) | | Grain Yield ( kg/ha) | | Straw Yield ( kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2012-13** | **2013-14** | **2012-13** | **2013-14** | **2012-13** | **2013-14** | **2012-13** | **2013-14** | **2012-13** | **2013-14** |
| $T_1$ | 24.00 | 15.00 | 260.13 | 129.14 | 16.34 | 17.11 | 6503 | 6231 | 8965 | 10740 |
| $T_2$ | 23.33 | 15.07 | 259.9 | 136.72 | 17.34 | 16.89 | 6555 | 6243 | 8429 | 10721 |
| $T_3$ | 20.00 | 15.07 | 247.6 | 125.92 | 16.12 | 17.11 | 5890 | 5760 | 8693 | 9535 |
| $T_4$ | 24.67 | 16.27 | 288.13 | 139.84 | 17.49 | 17 | 6839 | 6328 | 9118 | 10690 |
| $T_5$ | 24.33 | 15.53 | 242.87 | 138.4 | 16.98 | 16.98 | 5989 | 6295 | 8813 | 10454 |
| $T_6$ | 22.10 | 15.13 | 252.73 | 136.32 | 16.22 | 17.01 | 5920 | 6380 | 8825 | 10599 |
| $T_7$ | 26.67 | 17.2 | 317.47 | 147.24 | 18.1 | 17.96 | 6979 | 6642 | 9233 | 10888 |
| $T_8$ | 17.33 | 14.07 | 229.27 | 125.89 | 16.11 | 16.21 | 4672 | 5292 | 8487 | 9342 |
| SEd | 1.32 | 0.92 | 0.92 | 6.29 | 1.82 | - | 101.55 | 68.49 | 232.53 | 97.78 |
| CD (0.05 %) | 2.88 | 2.02 | 2.02 | 13.72 | 3.19 | NS | 221.28 | 149.24 | 506.69 | 213.07 |

 

**Table -3 : Effect of chemicals on Economics of paddy at maturity stage during navarai season (2012-13 and 2013-14)**

| Trt. | Cost of cultivation (Rs) ha$^{-1}$ | | Gross income (Rs) ha$^{-1}$ | | Net income (Rs) ha$^{-1}$ | | B:C ratio | |
|---|---|---|---|---|---|---|---|---|
| | **2012-13** | **2013-14** | **2012-13** | **2013-14** | **2012-13** | **2013-14** | **2012-13** | **2013-14** |
| $T_1$ | 33,780 | 37210 | 97,986 | 81101 | 43891 | 64,206 | 2.89 | 2.17 |
| $T_2$ | 33,456 | 37115 | 97,858 | 81191 | 44075 | 65,668 | 3.04 | 2.18 |
| $T_3$ | 33.489 | 37187 | 89,609 | 74282 | 36762 | 57,024 | 2.75 | 1.99 |
| $T_4$ | 33,968 | 37352 | 1,02,584 | 81991 | 44641 | 68,616 | 3.02 | 2.19 |
| $T_5$ | 34,761 | 37235 | 91,076 | 81259 | 44024 | 56,315 | 2.62 | 2.18 |
| $T_6$ | 34,691 | 37216 | 90,197 | 82352 | 45136 | 55,506 | 2.6 | 2.21 |
| $T_7$ | 33,830 | 37182 | 1,04,537 | 85477 | 48295 | 70,707 | 3.09 | 2.29 |
| $T_8$ | 33,000 | 36507 | 73,466 | 69264 | 32732 | 41,050 | 2.21 | 1.89 |
| SEd | - | - | - | - | - | - | - | - |
| CD (0.05 %) | NA | NA | NA | NA | NA | NA | NA | NA |

 

**Table. 4. Pooled analysis of the effect of chemicals on yield attributes and economics of paiyur -1 paddy during navarai 2012-13 + Navarai 2013-14**

| Tr. | Chemicals | Grain yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | Gross income (Rs ha$^{-1}$) | Net income (Rs ha$^{-1}$) | B:C ratio |
|---|---|---|---|---|---|---|
| $T_1$ | Salicylic acid (100 ppm) | 6367 | 9853 | 89544 | 54049 | 2.53 |
| $T_2$ | Calcium ammonium nitrate (0.5%) | 6399 | 9575 | 89525 | 54872 | 2.61 |
| $T_3$ | Potassium chloride (0.5%) | 5825 | 9114 | 81946 | 46893 | 2.37 |
| $T_4$ | Uniconazole (50 ppm) | 6584 | 9904 | 92288 | 56629 | 2.61 |
| $T_5$ | Silicic acid (0.1%) | 6142 | 9634 | 86168 | 50170 | 2.40 |
| $T_6$ | Ascorbic acid (100 ppm) | 6150 | 9712 | 86275 | 50321 | 2.41 |
| $T_7$ | Zinc Sulphate (0.5 %) | 6811 | 10061 | 95007 | 59501 | 2.69 |
| $T_8$ | Control ( no application) | 4982 | 8915 | 71365 | 36891 | 2.05 |
| | S Ed | 36.76 | 69.50 | - | - | - |
| | CD (P=0.05) | 80.12 | 137.97 | NA | NA | NA |

DAS: Days after sowing, f b: followed by, NA: Not analyzed

**Table -5: Range and mean of weather parameters from December to January of navarai season 2012- 13 and 2013-14**

| Weather parameters | Season I Navarai (2012 –13 ) | | Season II Navarai (2013 –14 ) | | Overall date ( Two seasons) | |
|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean |
| Maximum temperature ($^o$C ) | 28 - 36 | 32.10 | 29 - 33 | 31.15 | 28 -33 | 32.10 |
| Minimum temperature ($^o$C ) | 17 - 25 | 20.50 | 12 -20 | 18.09 | 12-25 | 20.5 |
| Sunshine (hr. day$^{-1)}$) | 7 - 11.3 | 9.78 | 8 -11.3 | 9.52 | 7-11.3 | 9.78 |
| Relative humidity (Mor.) | 82 - 96 | 88.03 | 75 -85 | 80.56 | 75 - 96 | 84.29 |
| Relative humidity (Eve.) | 39 - 50 | 44.7 | 35 - 49 | 40.06 | 35 -50 | 4 2.38 |
| Rainfall (mm) | 4 - 14 | 8.33 | 4.8 – 8.4 | 6.6 | 4 -14 | 7.46 |
| Soil temperature ($^o$C ) | 12 - 15 | 9.75 | 12 -16 | 13.0 | 12 -16 | 11.37 |

 