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# Penoxsulam evaluation for weed control efficacy and increased rice yield

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**ABSTRACT**

Field experiments were conducted for two years at wetland farm, Tamil Nadu Agricultural University, during *Kharif* seasons of 2014 and 2015 (June to October) to evaluate the penoxsulam (21.7% SC) for weed control in rice. Based on two years data, it was found that pre-emergence application of penoxsulam 22.5 g/ha resulted in significantly lower total weed density, weed dry weight and higher weed control efficiency at all the intervals. Application of penoxsulam could keep the weed density and dry weight below the economic threshold level and increase grain yield of 5.21 and 5.04 t/ha was obtained in 2014 and 2015, respectively. Unweeded control accounted for lower grain yield and higher weed index of 48.7 and 60.8%, respectively.

**Key words:** Rice, Soluble concentrate, Weed density, Weed dry weight, Weed control efficiency

Rice (*Oryza sativa* L.) is the staple food for about 50% of the world's population. In India, rice is cultivated in an area of about 44.10 million hectares (Mha) with a production of 105.31 million tones (MT) and in Tamil Nadu, the area is 2.01 Mha with production of 4.58 Mt (FAO 2012). Geometric growth of population and arithmetic increase in food grain production leave a vast gap in food supply. This gap is further widened due to urbanization and industrialization of fertile lands. The global requirement of rice by 2025 AD is expected 800 million tonnes, which is 26% higher than the present level of production. Rice crop suffers from various biotic and abiotic production constraints. Weed competition is one of the prime yield-limiting biotic constrains in rice. Weeds compete with crops for water, light, nutrients and space. Weeds are the most competitive in their early growth stages than at later stages grain yield (Jocob and Syriac 2005). The reduction in rice yield due to weed competition ranged from 9 -51% (Mani *et al.* 1986).

Among different rice establishment methods, the transplanted rice play vital role in terms of rice production in country. But, the transplanted rice is infested with wide range of weed species *viz.*, grasses, sedges and broad-leaved weeds. *Echinochloa cruss-galli* and *Cyperus difformis* are the most predominant and highly competetive with rice crop right from the planting till harvesting stage, whereas sedge weed *Cyperus difformis* competes with the crop during the early phase because of its shorter life cycle. Barua *et al.* (2008) reported 30 to 60 days after transplanting as critical period of crop weed competition. Reduction in grain yield due to unchecked weed infestation in transplanted rice varied between 29 to 63% (Bhuvaneswari *et al*. 2009). Therefore, evaluation of new herbicides for broad spectrum control of weed flora is imperative. Recent trend of herbicide use is to find out an effective weed control measure by using low dose high efficiency herbicides, which will not only reduce the total volume of herbicide use but also increase grain production (Kathiresan 2001). Therefore, the present study was undertaken to evaluate the performance of penoxsulam in transplanted *Kharif* rice and associated weeds.

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## MATERIALS AND METHODS

Experiment were laid out during *Kharif* season (June to October) of 2014 and 2015 at the wetland farm of Tamil Nadu Agricultural University, Coimbatore. The geographical location of the experiment site was $11^0$ N latitude and $77^0$ E longitude with an altitude of 426.7 m above the MSL and the farm receives the total rainfall of 696 mm in 42 rainy days. The soil of the experimental site was well drained clay loam (44.5% clay, 10.2% silt and 45.7% sand), low in available nitrogen, medium in available phosphorus and high in available potassium. The soil analyzed 234, 15.8 and 467 kg/ha of $KMno_4$-N, olsen P and $NH_4OAc$-K, respectively with EC of 0.29 ds/m, pH of 8.58 and organic carbon of 0.58%. The experiment was laid out in randomized complete block design (RBD) with nine treatments replicated

thrice. The gross plot and net plot size were 20 $m^2$ (5.0 x 4.0 m). Short duration rice variety '*ADT 43*' maturing in 100-110 days was used for the study. Treatments consisted of pre-emergence application of penoxsulam at 20, 22.5, 25 and 50 g/ha, butachlor (50% EC 1.0 kg/ha) and pretilachlor (50% EC) 750 g/ ha as standard check, hand weeding and unweeded check. The herbicides as pre-emergence were applied at third day after transplanting followed by a hand weeding on 30 DAT. Hand operated knapsack sprayer fitted with a flat fan type nozzle (WFN 40) was used for spraying the herbicide adopting a spray volume of 500 L/ha. The recommended dose of 130:40:40 kg NPK/ha in the form of urea, single super phosphate and muriate of potash were applied to all plots uniformly in lines and fifty per cent of nitrogen was applied as basal while, the remaining dose was top dressed in tillering and panicle initiation in equal splits. Data were recorded on predominant weed flora, weed density and dry weight of weeds. The weed related observations were recorded as per the standard procedure and the data were statistically analyzed by following the procedure as given by Gomez and Gomez (2010).

## RESULTS AND DISCUSSION

### Effect on weeds

The weed flora of the experimental field consisted of grasses, sedges and broad-leaved weeds which were observed from the unweeded check plot at flowering stage of rice. The pre-dominant grassy weeds were *Echinochloa crus-galli* (L.) and *Echinochloa colona* (L) and the dominant sedge was *Cyperus difformis* (L). Among the broad-leaved weeds, *Ammania baccifera* (L.), *Eclipta alba* (L) and *Marsilea quadrifoliata* (L) were the dominant species.

### Weed density

Pre-emergence application of penoxsulam at 20, 22.5, 25, 27.5 and 50 g followed by one hand weeding on 30 DAT resulted in effective control of grass weeds, broad-leaved weeds and to some extent sedges due to its broad spectrum action (**Table 1**). Pre emergence application of penoxsulam at low dose of 22.5 g/ha followed by standard check pretilachlor 50% EC 750 g/ha gave more impressive control of grass weeds like *Echinochloa crus-galli* and *Echinochloa colona*. This might be because of penoxsulam has both residual and burn down activity, therefore it could controlled susceptible weeds emerged at the time of application or which germinated soon after application (Willingham *et al.*, 2008). Similar to this result, Ottis *et al.* (2003) also reported that application of penoxsulam provided 99 and 97% control of *Echinochloa crus-galli* and *Brachiaria platyphylla* at 21 DAT.

This was due to the fact that herbicides followed by hand weeding or hand-hoeing is much effective compared with application of herbicides alone in rice because of weed emerging later in the season that can be effectively controlled with physical methods without crop injury (Farooq 2011).

### Weed dry weight and weed control efficiency

Weed dry weight is the important parameter to assess the weed competitiveness for the crop growth and productivity. Sparse weed with high biomass might be more competitive for crops than dense weeds with lesser dry matter. Considerable reduction in weed dry weight was recorded with application of penoxsulam at 22.5 g/ha at all the stages of observation and it was followed by standard check of pretilachlor (**Table 2**).

**Table 1. Effect of different weed management practices on total weed density in rice**

| Treatment | Weed density (no./$m^2$) | | | | | |
|---|---|---|---|---|---|---|
| | *Kharif* 2014 | | | *Kharif* 2015 | | |
| | 15 DAT | 30 DAT | 45 DAT | 15 DAT | 30 DAT | 45 DAT |
| Penoxsulam 20 g/ha + HW 30 DAT | 6.16 (38) | 8.28 (67) | 8.96 (79) | 6.16 (36) | 10.03 (99) | 8.17 (65) |
| Penoxsulam 22.5 g/ha + HW 30 DAT | 3.23 (9) | 4.61 (19) | 4.70 (20) | 3.00 (7) | 3.87 (13) | 3.46 (10) |
| Penoxsulam 25 g/ha + HW 30 DAT | 5.88 (35) | 7.92 (61) | 8.66 (74) | 2.99 (7) | 4.35 (17) | 3.99 (14) |
| Penoxsulam 27.5 g/ha + HW 30 DAT | 5.52 (30) | 7.42 (54) | 8.20 (65) | 5.83 (32) | 9.74 (93) | 7.93 (61) |
| Penoxsulam 50 g/ha + HW 30 DAT | 5.23 (26) | 7.08 (48) | 7.95 (62) | 3.60 (11) | 5.38 (27) | 5.38 (27) |
| Std. check butachlor 1000 g/ha + HW 30 DAT | 4.11 (15) | 5.65 (30) | 5.68 (30) | 3.60 (11) | 5.74 (31) | 5.74 (31) |
| Std. check pretilachlor 750 g/ha + HW 30 DAT | 3.70 (12) | 5.12 (25) | 5.16 (25) | 3.60 (11) | 6.07 (35) | 6.07 (35) |
| Hand weeding | 12.53 (157) | 6.12 (36) | 6.21 (37) | 11.59 (133) | 7.19 (50) | 7.12 (49) |
| Unweeded control | 13.09 (173) | 14.73 (221) | 12.69 (163) | 12.91 (165) | 18.34 (335) | 15.54 (240) |
| LSD (p=0.05) | 1.01 | 1.75 | 1.54 | 0.73 | 0.83 | 0.72 |

Figures in parentheses are original, transformed to values $\sqrt{x+2}$

**Table 2. Total weed dry weight and weed control efficiency as influenced by different weed management practices in rice (*Kharif* 2014)**

| Treatment | Weed dry weight (g/m$^2$) | | | Weed control efficiency (%) | | |
|---|---|---|---|---|---|---|
| | 15 DAT | 30 DAT | 45 DAT | 15 DAT | 30 DAT | 45 DAT |
| Penoxsulam 20 g/ha + HW 30 DAT | 4.19 (16.34) | 5.59 (29.33) | 6.04 (34.63) | 77.0 | 68.8 | 51.5 |
| Penoxsulam 22.5 g/ha + HW 30 DAT | 2.39 (3.80) | 3.24 (8.52) | 3.24 (8.92) | 94.7 | 90.9 | 87.5 |
| Penoxsulam 25 g/ha + HW 30 DAT | 4.04 (15.24) | 5.36 (26.95) | 5.84 (32.37) | 78.6 | 71.3 | 54.7 |
| Penoxsulam 27.5 g/ha + HW 30 DAT | 3.80 (12.87) | 5.03 (23.51) | 5.54 (28.72) | 81.9 | 75.0 | 59.8 |
| Penoxsulam 50 g/ha + HW 30 DAT | 3.58 (11.09) | 4.81 (21.26) | 5.38 (27.08) | 84.4 | 77.4 | 62.1 |
| Std. check butachlor 1000 g/ha + HW 30 DAT | 2.89 (6.54) | 3.89 (13.19) | 3.91 (13.35) | 90.8 | 86.0 | 81.3 |
| Std. check pretilachlor 750 g/ha + HW 30 DAT | 2.66 (5.17) | 3.56 (10.82) | 3.54 (11.12) | 92.7 | 88.5 | 84.4 |
| Hand weeding | 8.23 (65.96) | 4.20 (15.67) | 4.29 (16.46) | 7.2 | 83.3 | 77.0 |
| Unweeded control | 8.47 (71.08) | 9.61 (93.92) | 8.33 (71.40) | 0.0 | 0.0 | 0.0 |
| LSD (p=0.05) | 0.66 | 1.14 | 1.19 | - | - | - |

Figures in parentheses are original, transformed to values $\sqrt{x+2}$

**Table 3. Total weed dry weight and weed control efficiency as influenced by different weed management practices in rice (*Kharif* 2014 and 2015)**

| Treatment | Weed dry weight (g/m$^2$) | | | Weed control efficiency (%) | | |
|---|---|---|---|---|---|---|
| | 15 DAT | 30 DAT | 45 DAT | 15 DAT | 30 DAT | 45 DAT |
| Penoxsulam 20 g/ha + HW 30 DAT | 4.48(18.11) | 6.83(44.8) | 6.39(39.00) | 78.24 | 69.3 | 67.64 |
| Penoxsulam 22.5 g/ha + HW 30 DAT | 2.53(3.54) | 2.53(4.40) | 2.65(5.05) | 95.75 | 97.0 | 95.81 |
| Penoxsulam 25 g/ha + HW 30 DAT | 2.36(3.62) | 2.82(6.00) | 2.98(6.89) | 95.65 | 95.9 | 94.28 |
| Penoxsulam 27.5 g/ha + HW 30 DAT | 4.26(16.24) | 6.63(42.00) | 6.21(36.60) | 80.48 | 71.2 | 69.63 |
| Penoxsulam 50 g/ha + HW 30 DAT | 2.75(5.56) | 3.46(10.00) | 3.93(13.62) | 93.31 | 93.2 | 88.70 |
| Std. check butachlor 1000 g/ha + HW 30 DAT | 2.75(5.54) | 3.69(11.60) | 4.18(15.70) | 93.34 | 92.1 | 86.97 |
| Std. check pretilachlor 750 g/ha + HW 30 DAT | 2.74(5.51) | 3.89(13.20) | 4.42(17.85) | 93.38 | 91.0 | 85.19 |
| Hand weeding | 8.27(67.02) | 4.68(20.00) | 5.13(24.66) | 19.47 | 86.3 | 79.54 |
| Unweeded control | 9.21(83.23) | 12.15(146.00) | 11.01(120.53) | 0.00 | 0.0 | 0.00 |
| LSD (p=0.05) | 0.63 | 0.53 | 0.80 | - | - | - |

Figures in parentheses are original, transformed to values $\sqrt{x+2}$

Weed control efficiency was highly influenced by different weed control treatment. The application of penoxsulam 22.5 g resulted in the minimum weed count, weed dry matter production and the maximum weed control efficiency at 45 DAT in 2014 (**Table 2**) and pooled data of 2014 and 2015 (**Table 3**).

**Phytotoxicity effect on rice**

Phytotoxic effect of herbicides on rice was evaluated by observing for wilting, necrosis, epinasty, hyponasty and chlorosis of leaf tips/surface at 7, 14, 21 and 28 days after application (DAA). The observation on the level of phytotoxicity through visual assessment of crop response was rated in the scale of 1-10.

The mean phyto-toxicity scoring on rice at 7, 14, 21 and 28 days after application herbicides revealed that application of penoxsulam 21.7% SC at applied doses did not produce any phytotoxic symptoms such as chlorosis or epinasty or leaf tip burning on rice crop and herbicide was found completely safe for use in transplanted rice. The findings were in close conformity with the findings of Mubeen *et al*. (2014) *Mishra et al.* (2004), Bond *et al.* 2007 and Pal *et al.* (2009).

**Effect on rice crop**

Pre-emergence application of penoxsulam 22.5 g/ha recorded higher grain yield of 5.21 and 5.04 t/ha in 2014 and 2015, respectively and it was at par with pre-emergence application of pretilachlor 50% EC 750 g/ha (5.11 and 5.00 t/ha) due to better control of weeds at critical stages thus providing favourable environment for better growth and development leading to enhanced grain yield (**Table 4**). Hand weeding has recorded grain yield of 4.96 t/ha.

Among the weed control methods, higher weed index of 48.71 and 60.82% was recorded in unweeded control, which might be due to greater competition stress with prolific weed growth and higher nutrient removal by weeds. Based on the result of present investigation, it could be concluded that the pre-emergence application of penoxsulam at 22.5 g/ha can keep the weed density and dry weight

**Table 4. Effect of weed management treatments on yield and weed index of rice**

| Treatment | *Kharif, 2014* | | | *Kharif, 2015* | | |
|---|---|---|---|---|---|---|
| | Grain yield (t/ha) | Straw yield (t/ha) | Weed index (%) | Grain yield (t/ha) | Straw yield (t/ha) | Weed index (%) |
| Penoxsulam 20 g/ha + HW 30 DAT | 3.89 | 7.40 | 25.02 | 2.76 | 5.28 | 45.18 |
| Penoxsulam 22.5 g/ha + HW 30 DAT | 5.21 | 10.16 | 00.00 | 5.04 | 10.89 | 0.00 |
| Penoxsulam 25 g/ha + HW 30 DAT | 3.90 | 7.69 | 25.04 | 4.32 | 8.92 | 14.35 |
| Penoxsulam 27.5 g/ha + HW 30 DAT | 3.95 | 7.79 | 24.12 | 3.20 | 6.00 | 36.55 |
| Penoxsulam 50 g/ha + HW 30 DAT | 4.00 | 8.00 | 23.16 | 3.98 | 8.19 | 21.15 |
| Std. check butachlor 1000 g/ha + HW 30 DAT | 5.05 | 10.01 | 2.99 | 3.92 | 7.92 | 22.28 |
| Std. check pretilachlor 750 g/ha + HW 30 DAT | 5.11 | 10.05 | 1.84 | 5.00 | 10.50 | 0.87 |
| Hand weeding | 4.96 | 9.54 | 4.72 | 4.06 | 8.92 | 19.58 |
| Unweeded control | 2.67 | 6.05 | 48.71 | 1.97 | 4.50 | 60.82 |
| LSD (p=0.05) | 0.52 | 0.64 | - | 0.55 | 1.18 | - |

reasonably at lower level and enhance the productivity of transplanted rice resulting in higher economic returns.

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