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Yellow-green algae (*Vaucheria* sp.): A new weed reported in transplanted rice from the coastal Karnataka and its management

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ABSTRACT

Vaucheria species from the coastal region of Karnataka were collected from a rice field during *Kharif* season from Kota hobli, Udupi Taluk, Coastal Karnataka. These were identified as *V. sessilis* (VAUCHER) DC and *V.geminata* (VAUCHER) DC. A field experiment was conducted during *Kharif* season of 2017 and 2018 at farmer's field Kota, Udupi taluk, Coastal Karnataka, India for the management of these algal species. Among herbicide combinations, pre-emergence application of pendimethalin at 750 g/ha at 3 DAT *fb* post-emergence application of penoxsulam at 22.5 g/ha at 15, 30 and 45 DAT recorded lower dry weight (6.0, 5.6 and 4.8 g/m^2 respectively) with higher weed control efficiency (92.37%). This treatment also recorded significantly higher plant height (95.18 cm), a higher number of tillers per hill (25.75), grain yield (5.33 t/ha), straw yield (6.24 t/ha) with B:C ratio (2.09-2.11).

INTRODUCTION

Rice (*Oryza sativa* L.) is the world's most important food crop catering the need of half of the world's population. Weeds are one of the major problems in increasing the productivity of rice. Transplanted rice faces the diverse type of weed flora consisting of grasses, broad-leaved weeds, sedges and algae. They usually grow faster than rice and absorb available water, nutrient earlier than the rice and suppress rice growth.

Vaucheria species belongs to family Vaucheriaceae, phylum Xanthophyta, commonly known as yellow-green algae are non-motile, single-celled or colonial algae, with a distinctive pigmentation that gives the cells a yellow or fresh green appearance. Although there is a wide range in morphology, this phylum contains relatively few species (compared to major groups such as green algae) and the mentioned algae tend to be ecologically restricted to small water bodies and damp soils. In Karnataka, *Vaucheria* species was first noticed at Kota hobli (13°302 543 N latitude 74°422 203 E longitude at an altitude of 18 meters above MSL) of Udupi Taluk in an area of 20 acres in a rice field during *Kharif* season (Johnson and Merrit 2002). This weed competes for the nutrients, water and sunlight with the rice crop and forms the green mat in the growing area and it won't allow the crop to produce tillers. Its life cycle is hardly 40 days, appears in the field soon after the transplanting of the crop (Zelazna-Wieczorek 2002). Removal of weed manually is tedious and costly. Use of conoweeder is not advisable because while passing of conoweeder, algae easily disperse due to its vegetative mode of propagation. In some instances, herbicides alone offer the most practical, effective and economical means of reducing weed competition (Balasubramanian *et al.* 1996). However, the choice of the best specific herbicide varies with agronomic, ecological and economic factors. Herbicides not only control the weeds timely and effectively but also offer great scope for minimizing the cost of weed control irrespective of the situations. Keeping these points in view the experiment was carried out at Farmer's field of Kota, Udupi taluk of Coastal Karnataka.

MATERIALS AND METHODS

A Field experiment was conducted during (*Kharif*) rainy season 2017 and 2018 at the farmer's field of Kota, Udupi taluk, coastal Karnataka to study the effect of herbicides in transplanted rice with special reference to *Vaucheria* spp. of yellow-green algae (YGA) under 13°302 543 N latitude and 74°422 203 E longitude with an altitude of 18 m above MSL. The soil of experimental site was sandy loam having high organic carbon (1.23%), high available phosphorus (62.01 kg/ha) and medium available nitrogen (336 kg/ha) and potassium (159 kg/ha) with pH 5.20. Twelve treatments were assigned in a randomized block design with three replications. The coastal zone is characterized by hot and humid climate with heavy rains during *Kharif* (June to September) and dry spell from November to May. The total normal annual rainfall of the area was 3748.1 mm (1984-2018). The major portion of rain was received during June to September months. The mean maximum air temperature ranged from 29.58^0 to 34.80 0C and minimum from 18.38 ^{0} to 26.1^{0}C.

Twenty-one days old rice seedlings of medium duration red rice variety "*MO-4 (Bhadra)*" was transplanted at 20x10 cm spacing. The recommended dose of fertilizer (60:30:45 NPK kg/ha) was applied uniformly in three equal splits. Other agronomic and plant protection measures were adopted as recommended during crop growth. Quadrates (0.25 m^2) were placed in each plot at random. Weed fresh and dry weight within these quadrates were recorded.

All herbicides (**Table 1**) were applied using knap-sack sprayer fitted with flat-fan nozzle at spray volume of 500 L/ha at 3 DAT (pre-emergence) and 15 to 30 DAT (post-emergence) and compared with farmers practice (hand weeding at 15 DAT *fb* conoweeding at 30 and 45 DAT) and unweeded check. The data on fresh weight, dry weight and weed control efficiency were computed with the help of quadrate (0.25 x 0.25 m) and the values were subjected to square root transformation($\sqrt{x+0.5}$) prior to statistical analysis to normalize their distribution. Data on plant height (cm), number of tillers, grain yield (kg/ha), straw yield (kg/ha) and benefit cost ratio were recorded. The weed control efficiency was worked out based on weed dry matter production using the formula suggested by Mani *et al.* (1973). All the data obtained in the study were statistically analyzed using F-test, the procedure given by Gomez and Gomez (1984). Critical difference values at p=0.05 were used to determine the significance of differences between means.

RESULTS AND DISCUSSION

Weed flora

The predominant weed flora observed in the experimental field includes *Vaucheria* species of yellow-green algae, grassy weeds like *Panicum trypheron*, *Panicum repens*, *Echinochloa colona*, sedges like *Cyperus difformis*, *Cyperus procerus*, *Scirpus roylei*, broad-leaved weeds (BLW) like *Monochoria vaginalis*, *Ammania baccifera*, *Eclipta alba*, *Ludwigia parviflora*, and *Marsilea quadrifolia*.

Effect on weed density and dry weight

All the weed management treatments found effective in reducing the density and dry weight of *Vaucheria* spp. of yellow-green algae as compared to unweeded check (**Table 1**). At 15, 30 and 45 DAT, among different herbicide treatments, pre-emergence (PE) application of pendimethalin 750 g/ha at 3 DAT *fb* post-emergence (PoE) application of penoxsulam 22.5 g/ha at 30 DAT and PE application of pendimethalin 750 g/ha at 3 DAT *fb* PoE application of bispyribac-sodium 25 g/ha at 30 DAT were found more effective in controlling *Vaucheria* spp. as evidenced from lower fresh weight (32.8, 26.0, 13.2 and 35.6, 30.8,16.0 g/m^2, respectively), lower dry weight (6.0, 5.6,5.6 and 6.4,6.0, and 4.8 g/m^2, respectively). Pendimethalin being a broad-spectrum herbicide act as a mitotic poison by disrupting cell division and cell elongation through interference with microtubule assembly killing germinating seeds rather than seedlings. The herbicides penoxsulam and bispyribac-sodium belongs to group triazopyrimidine and pyrimidinyl (thio) benzoate, respectively. They act as ALS inhibitors retarding the synthesis of branched-chain amino acids valine, leucine, and isoleucine in plants by binding to the ALS enzyme, without these amino acids, protein synthesis and growth are inhibited, ultimately causing plant death. These findings are in line with Parthipan and Ravi (2014), Tranel and Wright (2002).

The crop yield is directly proportional to weed control efficiency, The weed control efficiency was maximum at 45 DAT with pendimethalin 750 g/ha at 3 DAT *fb* penoxsulam 22.5 g/ha at 30 DAT (**Table 1**), closely followed by pre-emergence application of pendimethalin 750 g/ha at 3 DAT *fb* PoE application of bispyribac-sodium 25 g/ha at 30. The similar results were reported by Deepthi and Subramanyam (2010) and Prabhakaran *et al.* (2014).

Growth, yield and yield attributing characters

The rice growth attributes, *viz*. plant height (cm) and no. of tillers at harvest and yield attributes, *viz*. total dry matter production, grain yield and straw yield were influenced significantly due to weed management treatments. Among the weed management treatments, pendimethalin 750 g/ha at 3 DAT *fb* penoxsulam 22.5 g/ha at 30 DAT found excellent in recording significantly higher growth and yield attributes as compared to others. However, it was at par with the pre-emergence application of pendimethalin *fb* bispyribac-sodium. Significantly the highest plant height (95.2 cm), a higher number of tillers per hill (25.7), total dry matter production (66.8

Table 1. Effect of weed management treatments on fresh weight, dry weight and weed control efficiency *Vaucheria* spp. of yellow-green algae in transplanted rice at different crop growth stages, pooled data (2017 and 2018)

Treatment	Fresh weight (g/m^2)			Dry weight (g/m^2)			Weed control efficiency (%)		
	15 DAT	30 DAT	45 DAT	15 DAT	30 DAT	45 DAT	15 DAT	30 DAT	45 DAT
Pretilachlor 750 g/ha at 3 DAT *fb* ethoxysulfuron 18.75 g/ha at 30 DAT	6.5 (41.6)	6.1 (37.2)	4.6 (20.8)	2.8 (7.6)	2.7 (6.8)	2.4 (5.2)	7.0 (49.2)	8.5 (71.6)	9.4 (88.9)
Pyrazosulfuron-ethyl 20 g/ha 3 DAT *fb* chlorimuron-ethyl + metsulfuron-methyl 4 g/ha at 30 DAT	6.4 (40.4)	6.0 (35.6)	4.5 (19.6)	2.8 (7.2)	2.6 (6.4)	2.3 (4.8)	7.2 (52.1)	8.6 (73.6)	9.6 (90.9)
Pendimethalin 750 g/ha at 3 DAT *fb* bispyribac-sodium 25 g/ha at 30 DAT	6.0 (35.6)	5.6 (30.8)	4.1 (16.0)	2.6 (6.4)	2.5 (6.0)	2.3 (4.8)	8.0 (63.6)	9.1 (82.4)	9.6 (91.3)
Butachlor 1000 g/ha at 3 DAT *fb* 2,4-D sodium salt 1000 g/ha at 30 DAT	7.1 (49.6)	6.8 (46.0)	5.3 (28.0)	2.8 (7.6)	2.8 (7.6)	2.5 (5.6)	6.8 (46.3)	7.7 (59.2)	9.3 (85.4)
Pendimethalin 750 g/ha at 3 DAT *fb* penoxsulam 22.5 g/ha at 30 DAT	5.8 (32.8)	5.1 (26.0)	3.7 (13.2)	2.5 (6.0)	2.5 (5.6)	2.3 (4.8)	8.5 (72.6)	9.4 (87.2)	9.6 (92.4)
Penoxsulam 22.5 g/ha at 15DAT *fb* 2,4-D sodium salt 1000 g/ha at 40 DAT	7.1 (50.4)	6.9 (46.8)	5.5 (29.6)	3.1 (9.2)	2.9 (8.0)	2.5 (6.0)	1.5 (1.7)	7.4 (54.8)	8.9 (79.4)
Bispyribac-sodium 25 g/ha at 15 DAT *fb* 2,4-D sodium salt 1000 g/ha at 40 DAT	6.9 (47.6)	6.6 (42.8)	5.1 (25.6)	3.1 (9.2)	2.8 (7.2)	2.4 (5.2)	2.3 (4.8)	7.9 (62.8)	9.3 (86.6)
Bispyribac-sodium 25 g/ha at 20 DAT *fb* one HW 40 DAT	7.0 (48.8)	6.6 (43.6)	5.2 (26.8)	3.1 (9.2)	2.8 (7.2)	2.4 (5.2)	2.0 (3.8)	7.8 (60.6)	9.4 (87.4)
Penoxsulam 22.5 g/ha 20 DAT *fb* one HW at 40 DAT	6.7 (44.0)	6.2 (38.7)	4.8 (22.4)	3.1 (9.2)	2.8 (7.2)	2.4 (5.2)	2.2 (4.3)	8.2 (66.8)	9.4 (88.6)
Chlorimuron-ethyl + metsulfuron-methyl 4 g/ha at 20 DAT *fb* one HW at 40 DAT	6.8 (45.2)	6.4 (40.4)	4.9 (24.0)	3.1 (9.2)	2.8 (7.2)	2.4 (5.2)	1.6 (2.2)	8.1 (64.8)	9.4 (87.4)
Farmers practice (hand weeding at 15 DAT *fb* conoweeding at 30 and 45 DAT)	6.3 (38.8)	5.9 (34.0)	4.4 (18.8)	3.0 (8.8)	2.6 (6.4)	2.3 (4.8)	2.4 (5.4)	8.7 (76.2)	9.4 (88.6)
Unweeded check	8.4 (70.4)	8.2 (67.2)	8.0 (63.6)	3.2 (10.0)	3.4 (10.8)	3.4 (11.2)	0.71 (0.0)	0.71 (0.0)	9.57 (91.0)
LSD (p=0.05)	1.3	6.0	5.6	0.3	0.2	0.2	5.0	7.3	9.7

Note: Square root $\sqrt{x+0.5}$ transformed values. Values in the parentheses are original values

Table 2. Plant height, no. of tillers, total dry matter production, grain yield, straw yield and economics as influenced by weed management treatments in transplanted rice at harvest

Treatment	Plant height at harvest (cm)	No. of tillers at harvest	Total dry matter production at harvest (g/hill)	Grain yield (t/ha)			Straw yield (t/ha)			B:C ratio
				2017	2018	Pooled	2017	2018	Pooled	
Pretilachlor 750 g/ha at 3 DAT *fb* ethoxysulfuron 18.75 g/ha at 30 DAT	88.6	23.3	62.4	4.86	4.95	4.9	5.84	5.92	5.89	1.98
Pyrazosulfuron-ethyl20 g/ha 3 DAT *fb* chlorimuron-ethyl + metsulfuron-methyl4 g/ha at 30 DAT	89.5	23.8	62.3	4.91	4.99	4.93	5.90	6.04	5.97	2.00
Pendimethalin750 g/ha at 3 DAT *fb* bispyribac-sodium 25 g/ha at 30 DAT	92.1	24.5	65.0	5.16	5.20	5.18	6.12	6.21	6.16	2.01
Butachlor 1000 g/ha at 3 DAT *fb* 2,4-D sodium salt 1000 g/ha at 30 DAT	84.8	20.5	53.7	4.30	4.36	4.33	5.36	5.47	5.42	1.78
Pendimethalin 750 g/ha at 3 DAT *fb* penoxsulam 22.5 g/ha at 30 DAT	95.2	25.7	66.8	5.33	5.35	5.33	6.22	6.26	6.24	2.09
Penoxsulam 22.5 g/ha at 15DAT *fb* 2,4-D sodium salt 1000 g/ha at 40 DAT	83.4	20.2	51.4	4.18	4.20	4.19	5.23	5.28	5.25	1.68
Bispyribac-sodium 25 g/ha at 15 DAT *fb* 2,4-D sodium salt 1000 g/ha at 40 DAT	85.8	21.9	55.2	4.60	4.65	4.63	5.59	5.65	5.62	1.81
Bispyribac-sodium 25 g/ha at 20 DAT *fb* one HW 40 DAT	85.3	21.2	53.4	4.49	4.49	4.49	5.45	5.62	5.53	1.68
Penoxsulam 22.5 g/ha 20 DAT *fb* one HW at 40 DAT	87.1	22.8	58.3	4.80	4.85	4.82	5.78	5.87	5.83	1.80
Chlorimuron-ethyl + metsulfuron-methyl 4 g/ha at 20 DAT *fb* one HW at 40 DAT	86.3	22.1	57.8	4.70	4.75	4.73	5.69	5.76	5.73	1.82
Farmers practice (hand weeding at 15 DAT *fb* conoweeding at 30 and 45 DAT)	90.5	23.9	63.1	4.99	5.05	5.02	5.99	6.04	6.02	1.86
Unweeded check	76.5	16.6	36.2	2.87	2.97	2.92	3.96	4.16	4.06	1.24
LSD (p=0.05)	4.8	1.3	2.7	0.50	0.50	0.50	0.60	0.60	0.60	-

g/hill) and higher grain yield (5.3 t/ha), straw yield (6.2 t/ha) with B:C ratio (2.09-2.11) was recorded in treatment application of pendimethalin at 750 g/ha at 3 DAT *fb* penoxsulam at 22.5 g/ha at 30 DAT (**Table 2**). The next best treatment was pre- pendimethalin at 750 g/ha at 3 DAT *fb* bispyribac-sodium 25 g/ha at 30 DAT as compared to unweeded check. The highest plant height of the specific treatments might be due to better nutrient utilization, accelerated cell enlargement and meristematic tissue development under the lower competition of weeds with the crop for light, nutrients and space along with the availability of water which allows the crop to grow to their potential. The higher yield in these treatments could be attributed to reduced weed density, weed biomass, better weed control efficiency, higher magnitude of growth parameters and helped to produce more photosynthates which were transformed into more number of productive tillers per hill helps in producing maximum grain yield. This was in line with the findings of Pandey and Tiwari (1996) and Saha (2005).

It was concluded that pre-emergence application of pendimethalin at 750 g/ha at 3 DAT *fb* PoE application of penoxsulam 24% CS at 22.5 g/ha at 30 DAT found most effective and economical in controlling the *Vaucheria* spp. of yellow-green algae in transplanted rice in coastal Karnataka.

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