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Growth and yield of foxtail millet as influenced by different weed management practices

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Abstract
A field experiment was carried out to study the post emergence herbicides efficacy in foxtail millet during *kharif*, 2020 at Agricultural College Farm, Bapatla. The experimental results revealed that the highest growth characters *viz.*, plant height (cm), number of tillers (No. m^{-2}), drymatter production (kg ha^{-1}), yield attributes *viz.,* number of panicles m^{-2}, panicle length, panicle weight, total grains $panicle^{-1}$, filled grains $panicle^{-1}$ and yield of foxtail millet were registered under the treatment T_2 (Hand weeding at 15 and 30 DAS). Among the herbicide applied treatments it's combination with cultural practice followed in the treatment T_8 (Interculture at 15 DAS *fb* ethoxysulfuron @ 18.75 g a.i ha^{-1} as PoE at 30 DAS) recorded the highest plant height, number of tillers, drymatter accural and grain yield, but did not differ statistically with the treatments T_2 (Hand weeding at 15 and 30 DAS), T_{10} (Interculture at 15 DAS *fb* hand weeding at 30 DAS), T_3 (Interculture at 15 and 30 DAS), T_7 (Interculture at 15 DAS *fb* chlorimuron ethyl (2 g a.i) + metsulfuron methyl (2 g a.i) @ 4 g a.i ha^{-1} as PoE at 30 DAS) and T_9 (Interculture at 15 DAS *fb* penoxsulam @ 20 g a.i ha^{-1} as PoE at 30 DAS).

Keywords: Foxtail millet, post emergence herbicides, growth, yield

Introduction
India is the major producer of many kinds of millets, which are referred to as coarse cereals. Millets designated as ancient super grains are considered as the reservoirs of nutrition, known for climate resilience and drought enduring capacity thus finding a place under contingency crop planning to overcome the risk posed by climate change (Kole *et al*., 2015) [5]. Among several millet crops, Foxtail millet (*Setaria italica*) is regarded as one of the oldest cultivated millets and is believed to be native to Southern Asia. India has an area of 72.6 thousand hectares with 50.2 thousand tonnes production and a productivity of 691 kg ha^{-1}. Andhra Pradesh from an area of 10 thousand hectares produces 4 thousand tonnes yield and has a productivity of 446 kg ha^{-1} (Directorate of Economics & Statistics, 2018-19).

Foxtail millet similar to other millets, also remains under-utilized as a food crop. However, is categorized nutritionally superior in providing proteins, dietary fibres, iron, zinc, calcium, phosphorus, potassium, vitamin B and essential amino acids at a cheaper cost (Hegde *et al*., 2005) [3]. The yield levels of millets in India are low because most of their cultivation is confined to resource poor marginal lands that to under rainfed conditions with meager inputs usage coupled with biotic and abiotic stresses of which efficient weed management assumes a major challenge.

Slow canopy formation in foxtail millet renders little shading of inter rows by mid-season leading to weed establishment. Moreover, weeds deprive these crops of vital nutrients and moisture resulting in reduced yields, lower grain quality of the crop besides resulting in increased production cost. Crop susceptibility to weed competition make weeds problematic during initial stages of the crop growth, effectuating the critical period of crop-weed competition. Therefore, an efficient mitigating strategy coupled with appropriate timely weed control is very much essential. To obtain the desired degree of weed control, although manual weeding is still the most adoptable common practice to achieve good yields, but at times, it becomes difficult owing to untimely rains. Further, this operation being laborious, time consuming besides being expensive, it is economically not a viable option under the present day intensive agriculture. In this context pursuing an appropriate post emergence herbicide for safe and effective weed control has become indispensable as a better choice in millets. While several workers have evaluated herbicides for weed control efficacy in sorghum, such recordings were limited in minor millets like foxtail millet due to which the present study was taken up to verify a selective post emergence herbicide for broad spectrum weed control in foxtail millet.

Material and Methods

A field experiment was carried out to study the post emergence herbicides efficacy in foxtail millet during *kharif*, 2020 at Agricultural College Farm, Bapatla. The soil of the experimental field was sandy clay in texture, neutral in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and potassium. The experiment was laid out in Randomized Block Design (RBD) with ten treatments, replicated thrice. The treatments comprised of *viz.*, Weedy check (T_1), Hand weeding at 15 and 30 DAS (T_2), Interculture at 15 and 30 DAS (T_3), Chlorimuron ethyl (2 g a.i) + metsulfuron methyl (2 g a.i) @ 4 g a.i ha^{-1} as PoE at 20 DAS (T_4), Ethoxysulfuron @ 18.75 g a.i ha^{-1} as PoE at 20 DAS (T_5), Penoxsulam @ 20 g a.i ha^{-1} as PoE at 20 DAS (T_6), Interculture at 15 DAS *fb* chlorimuron ethyl (2 g a.i) + metsulfuron methyl (2 g a.i) @ 4 g a.i ha^{-1} as PoE at 30 DAS (T_7), Interculture at 15 DAS *fb* ethoxysulfuron @ 18.75 g a.i ha^{-1} as PoE at 30 DAS (T_8), Interculture at 15 DAS *fb* penoxsulam @ 20 g a.i ha^{-1} as PoE at 30 DAS (T_9) and Interculture at 15 DAS *fb* hand weeding at 30 DAS (T_{10}). The Seeds @ 5 kg ha^{-1} were sown during *kharif* season manually in rows by mixing with sand in 1:3 ratio following a spacing of 25 cm x 10 cm on 27th August using 'Surya Nandi' variety. Thinning and gap filling were done at 10 DAS by keeping one seedling $hill^{-1}$. Nitrogen and phosphorus were applied through chemical fertilizers i.e., urea and single super phosphate, respectively in all the treatment plots. The recommended dose of nitrogen @ 40 kg ha^{-1} was applied in two equal splits *viz*., half as basal and remaining half as top dressing at 30 DAS and the entire quantity of phosphorus @ 30 kg ha^{-1} was applied as basal. Recommended agronomic and plant protection measures were followed. The data on number of tillers m^{-2} at 40 DAS, plant height, drymatter production and yield at harvest were recorded as per the standard statistical procedures. The data recorded on various parameters of growth and yield during the course of investigation were analysed statistically, applying the technique of analysis of variance procedure as outlined for complete randomized block design (RBD) suggested by Gomez and Gomez (1984). Whenever the treatment differences were found significant (F test) critical difference was worked out at 0.05 probability level and the values are furnished. The treatment differences that were not significant were expressed as non-significant and denoted by "NS".

Results and Discussion

All growth parameters *viz.*, plant height, number of tillers and drymatter production were significantly influenced by various weed management practices under the present study (Table 1). The highest plant height (127.34 cm), number of tillers (68.35 No. m^{-2}) and drymatter production (3746 kg ha^{-1}) were registered under the treatment T_2 (Hand weeding at 15 and 30 DAS), which was statistically comparable with T_{10}, T_3 and T_8. Among the herbicide applied treatments either alone or in combination with cultural practice, the treatment T_8 (Interculture at 15 DAS *fb* ethoxysulfuron @ 18.75 g a.i ha^{-1} as PoE at 30 DAS) recorded the highest plant height (119.65 cm), number of tillers (66.24 No. m^{-2}) and drymatter production (3580 kg ha^{-1}), which was however at par with the treatments T_7 and T_9 apart from T_2, T_{10} and T_3. The treatments (T_4, T_5 and T_6) consisting of exclusively chemical spray exhibited significant superiority over weedy check, but were distinctly inferior to the treatments involving combination of herbicide and interculture practice. The lowest plant height, number of tillers and drymatter production of foxtail millet (76.28 cm, 36.97 No. m^{-2} and 1683 kg ha^{-1}, respectively) were associated with the treatment Weedy check (T_1). This might be due to severe crop weed competition throughout the crop growth period, which adversely hampered the normal expansion of the crop.

Table 1: Plant height, number of tillers, drymatter production and yield of foxtail millet as influenced by different weed management practices

Treatments	Plant height (cm)	Number of tillers (No. m^{-2})	Drymatter production (kg ha^{-1})
T1	76.28	36.97	1683
T2	127.34	68.35	3746
T3	122.34	67.49	3590
T4	95.09	48.81	2699
T5	99.96	53.12	2769
T6	90.77	47.12	2576
T7	112.32	61.03	3195
T8	119.65	66.24	3580
T9	110.34	60.06	3097
T10	123.68	68.13	3655
SEm±	3.42	2.28	166.0
CD (P = 0.05)	10.15	6.78	493
CV%	5.49	6.85	9.4

Similar behavioural trend was displayed in respect of yield attributes and yield (grain yield and straw yield) as that of growth parameters under diversified weed control treatments (Table 2). The treatment T_2 (Hand weeding twice at 15 and 30 DAS) recorded the highest number of panicles (63.53 No. m^{-2}), panicle length (17.83 cm), panicle weight (5.55 g), total grains $panicle^{-1}$ (1011), filled grains $panicle^{-1}$ (989), grain yield (1512 kg ha^{-1}) as well as straw yield (2212 kg ha^{-1}), which was closely followed by treatments T_7 and T_9. While, the lowest number of panicles (33.73 No. m^{-2}), panicle length (11.47 cm), panicle weight (3.02 g), total grains $panicle^{-1}$ (676), filled grains $panicle^{-1}$ (617), grain yield (486 kg ha^{-1}) and straw yield (1189 kg ha^{-1}) were associated with treatment T_1 (Weedy check). Various weed control treatments failed to project a significant influence on the test weight of foxtail millet.

The enhanced yield attributes in the above weed management treatments was perhaps due to reduced crop weed competition, promoting adequate utilization of ample production resources. The consequences was increased production and translocation of photosynthates from source to sink. Significant enhancement of various yield attributing characters like number of panicle m^{-2}, filled grains $panicle^{-1}$, panicle length, panicle weight and 1000 grain weight might have led to a greater nutrient uptake by the crop due to minimum presence of weeds thus recasting a collective effect

on grain yield increment.

The availability of surplus nutrients to the crop, as a result of longer weed control impact by implementation of timely weed control measures could have resulted in vigorous crop development with more drymatter accumulation, which led to increased straw yield. Present study revealed that hand weeding at the time of critical period of crop growth resulted in the highest yield attributes and yield, which was also reported by Jawahar *et al*. (2019) [4]. The highest grain yield realization in implementation of hand weeding was also supported by Yendrembam *et al*. (2018) [13] in kodo millet and Prakash *et al.* (2017) [9] in rice. Among post emergence herbicides in compliance with intercultivation, ethoxysulfuron was found to be the best in enhancing the foxtail millet yield. Similar findings on impact of herbicide in increasing grain and straw yield was reported by Padmaja and Malla Reddy (2013) [7] and Sameer (2018) [10] with the application of ethoxysulfuron @ 18.75 g a.i. ha^{-1} in rice and ragi.

Table 2: Yield attributes and yield of foxtail millet as influenced by weed management practices

Treatments	Number of panicles m^{-2}	Panicle length (cm)	Panicle weight (g)	Number of grains panicle^{-1}	Number of filled grains panicle^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T1	33.73	11.47	3.02	676	617	2.49	486	1189
T2	63.53	17.83	5.55	1011	989	2.68	1512	2212
T3	61.60	17.38	5.24	971	945	2.67	1396	2119
T4	49.53	14.17	4.17	797	755	2.61	925	1550
T5	51.60	14.77	4.27	801	763	2.62	1018	1648
T6	47.07	13.90	4.14	790	744	2.61	901	1505
T7	56.63	15.63	5.01	902	873	2.64	1232	1936
T8	60.53	17.13	5.21	951	922	2.65	1384	2077
T9	55.50	15.54	4.99	888	849	2.63	1204	1902
T10	63.10	17.56	5.39	993	969	2.67	1466	2154
SEm±	2.24	0.78	0.18	36.0	35.1	0.11	60.9	84
CD (P = 0.05)	6.66	2.31	0.53	107	104	NS	181	250
CV%	7.15	8.66	6.55	7.1	7.2	7.35	9.2	8.0

Conclusion

Hand weeding twice at 15 and 30 DAS (T_2) is the efficient practice, which produced significantly highest values of growth characters, yield attributes and yield. Since, scarcity of labour at critical period of crop weed competition renders it impossible for timely weed control in foxtail millet, a combination of interculture practice with herbicidal spray (T_8) proved the best in increasing yield and found to be a suitable alternative to manual weeding.

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