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Effect of integrated weed management practices on weed parameters and yield of onion (*Allium cepa* L.)

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Abstract
A field experiment was conducted to study the effect of integrated weed management practices on weed parameters and yield of onion at college farm, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during *rabi* 2021. The experiment consisted of eleven treatments and laid out in randomised block design (RBD) with 3 replications. Results revealed that crop yield and weed parameters *viz*., weed density, weed dry matter, weed control efficiency and weed index were significantly influenced by weed management practices. Significantly lower weed infestation was recorded with mechanical weeding at 20 and 40 DAT and it was at par with pendimethalin 38.7% CS 677.25 g ha^{-1} PE + polyfilm mulch and oxyfluorfen 23.5% EC 100 g ha^{-1} PE + polyfilm mulch. Similarly, higher yield was recorded with mechanical weeding at 20 and 40 DAT (183.2 q ha^{-1}) and it was on par with pendimethalin 38.7% CS 677.25 g ha^{-1} PE + polyfilm mulch (176.3 q ha^{-1}) and oxyfluorfen 23.5% EC 100 g ha^{-1} PE + polyfilm mulch T_2 (173.2 q ha^{-1}). Hence it can be concluded that mechanical weeding at 20 and 40 DAT or pendimethalin 38.7% CS 677.25 g ha^{-1} PE + polyfilm mulch or oxyfluorfen 23.5% EC 100 g ha^{-1} PE + polyfilm mulch may be adopted to control weeds effectively and to get optimum yield.

Keywords: Integrated weed management practices, weed control efficiency, weed density, weed dry matter and weed index

1. Introduction
Vegetable crops in India play an important role in food and nutritional security. India being the largest in area, second in production and third in export of such crops, however there is an urgent requirement to boost vegetable production to meet the increasing demands of the population. Among the various vegetables, onions hold great significance as they are an essential component of many diets and are a key ingredient in numerous recipes. Onion bulb is rich in phosphorus, calcium and carbohydrates. Onion contains antioxidants and compounds that fight against inflammation, decrease triglycerides and reduce cholesterol levels all of which may lower heart disease risk. In India, it is grown in an area of 1.6 m ha with a total production of 26.83 million tonnes having an average productivity of 16.4 t ha^{-1} [India stat, 2022].
Weeds pose a significant challenge to the successful cultivation of onion crop. Numerous studies have indicated that onion has a limited ability to compete with weeds. Uncontrolled weed growth reduces the bulb yield up to 40-80% depending upon the nature of intensity and duration of weed competition in onion field [2]. The poor competitive ability of onions is due to short height, lack of branching, sparse foliage, shallow root system, and extremely slow initial growth [3]. Manual weeding in onion cultivation is costly, time-consuming, and requires frequent repetition. The unavailability of timely labour leads to ineffective weed control, resulting in reduced onion yields. Taking these points into consideration, the study was planned to find out effective integrated weed management practice to get higher yield of onion.

2. Material and Methods
The field experiment was carried out during *rabi* 2021-22, at College Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agriculture University, Hyderabad. The soil of experimental site was sandy loam in texture with pH 7.1, medium in organic carbon (0.71%), low in available nitrogen (233.7 kg ha^{-1}), high in available phosphorus

(32.71 kg ha^{-1}) and medium in potassium (334.24 kg ha^{-1}). The experiment consisted of 11 weed control treatments which were laid out in randomized block design with three replications. Bhima super (a red onion variety) seedlings were transplanted on 10th November, 2021 with a spacing of 30×10 cm. On the same day, fenugreek variety, Pusa early bunching sowing was taken up in respective treatment plots along with onion transplanting. A common fertilizer dose of 80 kg N, 32 kg P_2O_5 ha^{-1}and 24 kg ha^{-1} K_2O were applied to the field in the form of urea, SSP and MOP. In treatments involving stale seed bed, frequent irrigations were given for germination of weed flora and the entire weed flora germinated was uprooted by manual weeding prior to transplanting. A black polyethylene sheet of 30 mm gauge thickness was cut fixed between inter-rows of crop and fastened with the help of wooden pegs one week after transplanting. Pre emergence herbicides were applied within 24 hours after transplanting. Post emergence herbicides were applied at 2-3 leaf stage of weeds. At the time of application it was ensured that sufficient moisture was maintained in the soil. The herbicide spraying was done through knapsack sprayer using 500 liters of water per hectare. Biometric observations were taken on tagged five representative plants selected at random from each treatment of net plot and the mean values were presented.

2.1 Treatment details

- **T$_1$:** Oxyfluorfen 23.5% EC 100 g ha^{-1} pre-emergence (PE) + mechanical weeding at 30 DAT
- **T$_2$:** Oxyfluorfen 23.5% EC 100 g ha^{-1} PE + polyfilm mulch
- **T$_3$:** Pendimethalin 38.7% CS 677.25 g ha^{-1} PE + mechanical weeding at 30 DAT
- **T$_4$:** Pendimethalin 38.7% CS 677.25 g ha^{-1} PE + polyfilm mulch
- **T$_5$:** Stale seed bed *fb* propaquizafop 5% + Oxyfluorfen 12% EC 148 g ha^{-1} post-emergence (PoE)
- **T$_6$:** Stale seed bed *fb* quizalofop ethyl 4%+ Oxyfluorfen 6% EC 100 g ha^{-1} PoE
- **T$_7$:** Pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* propaquizafop 5%+ Oxyfluorfen 12% EC 148 g ha^{-1} PoE
- **T$_8$:** Pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* quizalofop ethyl 4% + Oxyfluorfen 6% EC 100 g ha^{-1} PoE
- **T$_9$:** Pendimethalin 38.7% CS 677.25 g ha^{-1} PE and intercrop with fenugreek
- **T$_{10}$:** Mechanical weeding at 20 and 40 DAT
- **T$_{11}$:** Weedy check.

3. Results and Discussion

3.1 Weed density (No. m^{-2})

Weed density was observed with quadrat at 60 DAT is presented in table 1. At 60 DAT the lowest total weed density was recorded in mechanical weeded plots at 20 and 40 DAT. This was comparable to pendimethalin 38.7% cs 677.25 g ha^{-1} PE + polyfilm mulch and oxyfluorfen 23.5% EC 100 g ha^{-1} PE + polyfilm mulch. These treatments were followed by pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* propaquizafop 5%+ oxyfluorfen 12% EC 148 g ha^{-1} POE, pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* quizalofop ethyl 4% + oxyfluorfen 6% EC 100 g ha^{-1} POE, pendimethalin 38.7% CS 677.25 g ha^{-1} PE + mechanical weeding at 30 DAT and oxyfluorfen 23.5% EC 100 g ha^{-1} PE + mechanical weeding at 30 DAT which were comparable with each other.

Lower density of weeds might be due to effective control of broad-spectrum weeds during critical period of crop weed competition by all weed control methods *i.e.*, cultural (stale seed bed and mulch), physical (mechanical weeding) and chemical methods (pre and post emergence application of herbicides). Malik *et al*. [4] reported similar findings in onion.

Table 1: Effect of integrated weed management practices on weed density, weed dry matter, WCE at 60 DAT, Weed index and bulb yield in onion

Treatments	Weed density (No. m^{-2})	Weed dry matter (g m^{-2})	WCE (%)	Weed index (%)	Bulb yield (q ha^{-1})
T$_1$	7.97 (62.48)	7.01 (48.40)	67.09	33.25	122
T$_2$	5.68 (31.30)	6.60 (42.99)	70.77	5.46	173
T$_3$	7.69 (58.07)	6.87 (46.64)	68.29	31.34	126
T$_4$	5.58 (30.14)	6.56 (41.97)	71.46	3.78	176
T$_5$	8.92 (78.54)	8.54 (72.02)	51.03	49.90	92
T$_6$	9.10 (81.80)	8.94 (78.91)	46.35	50.40	91
T$_7$	6.84 (45.72)	7.06 (48.79)	66.82	18.93	149
T$_8$	7.20 (50.78)	7.26 (51.75)	64.81	20.13	146
T$_9$	9.28 (85.14)	7.64 (57.73)	60.75	58.17	77
T$_{10}$	5.42 (28.35)	6.44 (40.46)	72.49	-	183
T$_{11}$	10.47 (108.58)	12.15 (147.08)	-	88.15	22
SEm±	0.37	0.13			8.0
CD (p=0.05)	1.20	0.36			23.5

Note: Figures in parenthesis are the original values; square root transformation (√x+1) used for statistical analysis

3.2 Weed dry matter (g m^{-2})

The data pertaining to influence of weed management practices on weed dry matter is presented in Table 1. However, magnitude of reduction in dry weight of weeds varied depending on the control measures adopted. At 60 DAT, the highest weed dry matter was noticed in un weeded control. Lower weed dry matter was recorded with mechanical weeding at 20 and 40 DAT and it was on par with mulch and herbicide treatment combination plots *i.e.*, pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* polyfilm mulch and oxyfluorfen 23.5% EC 100 g ha^{-1} PE *fb* polyfilm mulch. These were followed by herbicide treated plots which included treatment with pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* propaquizafop 5%+ oxyfluorfen 12% EC 148 g ha^{-1} PoE and pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* quizalofop ethyl 4% + oxyfluorfen 6% EC 100 g ha^{-1} PoE. Un weeded control consistently recorded the highest dry matter of weeds at all stages of the onion crop. The results are in accordance with the findings of Kalhapure *et al*. [5].

3.3 Weed control efficiency (%)

Weed control efficiency is a way of expressing in percentage the efficiency of different herbicide combinations. Weed control efficiency (WCE %) was worked out at 60 DAT based on the total dry weight of weeds in unweeded control and the data was

furnished in Table 1.

At 60 DAT highest weed control efficiency was registered with mechanical weeding at 20 and 40 DAT. The next superior treatments with high weed control efficiency were with pendimethalin 38.7% CS 677.25 g ha^{-1} PE + polyfilm mulch and oxyfluorfen 23.5% EC at 100 g ha^{-1} + polyfilm mulch. These were followed by pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* propaquizafop 5%+ oxyfluorfen 12% EC 148 g ha^{-1} PoE and pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* quizalofop ethyl 4% + oxyfluorfen 6% EC 100 g ha^{-1} PoE recorded the better weed control efficiency. Different integrated weed management practices effectively controlled weeds which led to lower dry matter accumulation in weeds and which in turn resulted in higher weed control efficiency when compared to weedy check. Similar observations were obtained by Sahoo *et al*. [6] and Urraiya and Jha [7].

3.4 Weed Index (%)

Weed index refers to reduction in crop yield due to the presence of weeds in comparison to weed free treatment. Lesser the weed index, better is the efficiency of a herbicide. Weed index was calculated for different weed management practices and is presented in Table 1.

Among the different integrated weed management practices, lower weed index was registered with pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* polyfilm mulch (3.78%), oxyfluorfen 23.5% EC at 100 g ha^{-1} + polyfilm mulch (5.46%), pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* propaquizafop 5%+ oxyfluorfen 12% EC 148 g ha^{-1} PoE (18.93%) and pendimethalin 38.7% CS 677.25 g ha^{-1} PE *fb* quizalofop ethyl 4% + oxyfluorfen 6% EC 100 g ha^{-1} PoE (20.13%). Lower weed index might be due to lower crop weed competition enabling the crop to utilize the resources like light, moisture and nutrients resulting in higher yields. The lower values of weed index are due to high weed control efficiency. On the contrary, higher weed index was observed with un weeded check (88.15%). The results are analogous to those obtained by Sahoo *et al*. (2017).

3.5 Bulb yield (q ha^{-1})

The data pertaining to influence of weed management practices on bulb yield is presented in Table 1. Integrated weed management practices significantly influenced bulb yield. Mechanical weeding at 20 and 40 DAT (183 q ha^{-1}) recorded significantly higher yield and it was on par with pendimethalin 38.7% CS 677.25 g ha^{-1} PE + polyfilm mulch (176 q ha^{-1}) and oxyfluorfen 23.5% EC 100 g ha^{-1} PE + polyfilm mulch treated plots (173q ha^{-1}).

Maximum yield in mechanical weeding treatment might be due to favourable environment created by clean crop culture resulting in efficient utilization of resources resulting in more photosynthetic rates and more dry matter accumulation. The results are similar to the findings of Sinare *et al*. [8]. in onion.

4. Conclusion

Results of the study revealed that mechanical weeding at 20 DAT and 40 DAT *i.e*., during the critical crop growth period had reduced the weed competition for the crop and produced more yield and net returns. Besides pre-emergence herbicide spray along with polyfilm mulch had produced the similar results indicating them as equally effective in suppressing the weeds. It can be concluded that instead of adopting single method of weed control in onion, combination of weed control measures could yield better results in terms of both productivity and profitability.

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6. Competing interests

Declaration of competing interest should be placed here. All authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding. If no such declaration has been made by the authors, SDI reserves to assume and write this sentence: "Authors have declared that no competing interests exist."

7. Authors' Contributions

Authors may use the following wordings for this section: "'Author A' designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. 'Author B' and 'Author C' managed the analyses of the study. 'Author C' managed the literature searches…… All authors read and approved the final manuscript."

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