

Bio-efficacy evaluation of herbicides for weed management in *rabi* onion

ABSTRACT

A field experiment entitled “Bio-efficacy evaluation of herbicides for weed management in *rabi* onion” was conducted at Weed Control Research Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) during *rabi* season of 2021-22 on medium black calcareous soil. The experiment comprising 14 treatments was laid out in randomized block design with three replications. The results revealed that next to weed free treatment, tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* HW at 40 DATP, tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha at 40 DATP and tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* pre-mix quizalofop + oxyfluorfen 100 g/ha at 40 DATP control of complex weed flora, reduced population and dry matter of weeds and having less reduction in yield due to better control of weeds, less crop-weed competition, higher weed control efficiency.

Keywords: herbicide mixtures, onion, weed, weed indices

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the *Alliaceae* family and is either biennial or perennial. It is native to Central Asia and the Mediterranean region. Onions must have been grown in India since very ancient times, as mentioned in the *Charak Sanhita*, a famous early medical treatise of India. Charak attributes many virtues to the onion. Onion has diuretic properties, is beneficial to the digestive tract, and is recommended for patients with high cholesterol, weakness and lack of vitality. Onion bulbs are rich in minerals, calcium, phosphorus, carbohydrate, proteins and vitamin-C (Rahman *et al.*, 2013). Onion is popularly known as “*Queen of kitchen*” because of its characteristic flavour and taste. It promotes appetite, is useful against malaria, night blindness and lowers the blood pressure (Perane, 2001). Major onion growing states in India are Maharashtra, Bihar, Rajasthan, Andhra Pradesh, West Bengal, Haryana and Uttar Pradesh.

Weed problems in onions are serious. Onion crops are more prone to weed menace and usually infested with a wide spectrum of broad leaf and grassy weeds. Onion has a shallow root system and non-branching habit makes onion crop weak competitor against weeds and it makes

Commented [k1]: (Gujarat), India

Commented [k2]: Do not use words already used in title for keywords!

Commented [k3]: Declare the research objectives in Abstract and/or in the last part of Introduction!

the crop unable to cover the soil surface for prevention of weed growth. Ultimately the crop facilitates the weed growth by encouraging favourable conditions with sufficient sunlight, air coupled with regular irrigation and high fertilization. The critical period for weed infestation is between 15 and 45 days after transplanting, resulting in a 69.3% reduction in bulb yield over weed free crop (Tewari *et al.*, 2003). Effective weed management practices during the critical crop growth stage are essential for obtaining an optimum economic yield. The most effective herbicide currently suitable for weed destruction in onion is oxyfluorfen, as reported by Stall and Gilreath (2002). The common weed management practice for onion is pre-emergence application of selective herbicides like pendimethalin, oxyfluorfen and oxadiazon followed by one hand weeding or use of post-emergences herbicides (Kalhapure *et al.*, 2014; Sinare *et al.*, 2014). Pre-emergence herbicides offer the most practical, effective and economical method of weed control to increase the bulb yield of onions (Ramalingam *et al.*, 2013). Herbicide combinations are more effective tool for taking weed menace, thereby nutrient depletion by them than a single herbicide approach (Upadhyay *et al.*, 2013). Chemical weed control, or the use of herbicides, is the only modern tool to manage crop-weed competition. It is easy and convenient to use, apart from that, it reduces the cost of labour required for the hand weeding.

MATERIALS AND METHODS

The experiment was conducted during *rabi* season of 2021-22 at Weed Control Research Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat). The mean maximum and minimum temperature during the crop growth and development period ranged from 24.7 to 42.8 °C and 9.4 to 26.3 °C, respectively. The soil of the experimental plot was clayey in texture, high in organic carbon (0.96%) and alkaline in reaction with pH 8.04 and EC 0.57 dS/m. The soil was medium in available nitrogen (406.00 kg/ha), high in available phosphorus (88.23 kg/ha) and available potassium (322.00 kg/ha).

The experiment having 14 treatments viz., pendimethalin 900 g/ha as pre-planting *fb* HW at 40 DATP (T₁), oxyfluorfen 240 g/ha as pre- planting *fb* HW at 40 DATP (T₂), tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre- planting *fb* HW at 40 DATP (T₃), oxadiargyl 75 g/ha as early post-emergence at 15 DATP *fb* HW at 40 DATP (T₄), tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre- planting *fb* quizalofop 40 g/ha at 40 DATP (T₅), tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre- planting *fb* propaquizafop 62.5 g/ha at 40 DATP (T₆), pendimethalin 625 g/ha as pre- planting *fb* pre-mix

Commented [k4]: Enrich with: planting and maintenance, observations, data statistical analysis

Commented [k5]: Please include the treatments in one single table to increase the readability of each treatment!

quizalofop + oxyfluorfen 100 g/ha at 40 DATP (T₇), oxyfluorfen 240 g/ha as pre-planting *fb* pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha at 40 DATP (T₈), tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* pre-mix quizalofop + oxyfluorfen 100 g/ha at 40 DATP (T₉), tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha at 40 DATP (T₁₀), pre-mix quizalofop + oxyfluorfen 100 g/ha as post-planting at 30 DATP (T₁₁), pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha as post-planting at 30 DATP (T₁₂), weed free check (HW at 15, 30, 45 and 60 DATP) (T₁₃), unweeded check (T₁₄) were laid out in RBD design with 3 replications. The gross and net plot size were 4.0 m x 2.4 m and 3.0 m x 1.8 m, respectively. The onion (*cv.* GJRO-11) was sown on 29th October, 2021 at 15 cm x 10 cm using for sowing in nursery for raising the seedlings with seed rate of 10 kg/ha and harvested on 21 April 2022. The onion was fertilized with 75-60-50 N-P₂O₅-K₂O kg/ha along with FYM 10 t/ha. The herbicides were sprayed as per treatments with the help of hand (knapsack) operating sprayer using flat fan nozzle with spray volume of 500 L/ha.

RESULTS AND DISCUSSION

A. Effect on total weed count

An analysis of the data found that the different weed management treatments had a notable impact on total weed count. Among the different weed management treatments, nearest to weed-free check, tank-mix pendimethalin 0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* HW at 40 DATP and tank-mix pendimethalin 0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha at 40 DATP recorded with the lowest total weed count at 20, 40, 60 DATP and at harvest. On contrary, unweeded check recorded significantly highest total weed count at 20, 40, 60 DATP and at harvest. These findings are in conformity with those of Udit *et al.* (2014) and Rakesh and Pramod (2021).

Table 1: Effect of various weed management treatments on total weed count

Treatments	Total weed count (No./m ²)			
	20 DATP	40 DATP	60 DATP	Harvest
T ₁ : Pendimethalin 0.90 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	2.72 (7.00)	3.34 (10.67)	3.07 (9.00)	3.58 (12.33)
T ₂ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	1.84 (3.00)	3.06 (9.00)	2.79 (7.33)	3.89 (14.67)

Commented [k6]: count (Table 1)

Commented [k7]: Please make explanation note of these two numbers!

T ₃ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI/ <i>fb</i> HW at 40 DATP	2.09 (4.00)	2.55 (6.00)	2.61 (6.33)	2.91 (8.00)
T ₄ : Oxadiargyl 75 g ha ⁻¹ as early PoE at 7 DAS <i>fb</i> HW at 40 DATP	3.02 (8.67)	3.64 (13.00)	3.28 (10.33)	3.94 (15.00)
T ₅ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI/ <i>fb</i> quizalofop 40 g ha ⁻¹ at 40 DATP	2.45 (5.67)	3.12 (9.33)	3.18 (9.67)	4.02 (15.67)
T ₆ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI/ <i>fb</i> propaquizafop 62.5 g ha ⁻¹ at 40 DATP	2.81 (7.67)	3.61 (12.67)	3.52 (12.00)	4.25 (17.67)
T ₇ : Pendimethalin 0.625 kg ha ⁻¹ as PPI/ <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	2.84 (7.67)	3.08 (9.00)	3.13 (9.33)	3.67 (13.00)
T ₈ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI/ <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	2.48 (5.67)	2.73 (7.00)	2.66 (6.67)	3.13 (9.33)
T ₉ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI/ <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	2.26 (4.67)	2.80 (7.33)	2.41 (5.33)	3.07 (9.00)
T ₁₀ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI/ <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	1.93 (3.33)	2.24 (4.67)	2.26 (4.67)	2.72 (7.00)
T ₁₁ : Pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ as PoE at 30 DATP	4.17 (17.00)	3.70 (13.33)	4.41 (19.00)	4.88 (23.33)
T ₁₂ : Pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ as PoE at 30 DATP	4.19 (17.33)	3.72 (13.33)	4.41 (19.00)	5.03 (25.00)
T ₁₃ : Weed free check	0.71 (0.00)	1.34 (1.33)	1.46 (1.67)	1.95 (3.33)
T ₁₄ : Unweeded check	5.34 (28.00)	6.18 (38.00)	6.72 (44.67)	7.35 (53.67)
S.Em.±	0.25	0.21	0.14	0.16
C.D. at 5%	0.72	0.62	0.42	0.48
C.V.%	15.48	11.49	7.65	7.33

PPI: pre-planting, PoE: post-emergence, HW: Hand weeding, DATP: Days after transplanting

Table 2: Effect of diverse weed management treatments on dry weight of total weeds

Treatments	Dry weight of total weeds (g/m ²)			
	20 DATP	40 DATP	60 DATP	Harvest
T ₁ : Pendimethalin 0.90 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	0.89	2.45	18.80	26.92
T ₂ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	0.70	2.66	18.55	31.23
T ₃ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	0.30	0.89	7.67	15.67
T ₄ : Oxadiargyl 75 g ha ⁻¹ as early PoE at 7 DAS <i>fb</i> HW at 40 DATP	0.97	2.84	22.38	39.77
T ₅ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> quizalofop 40 g ha ⁻¹ at 40 DATP	0.79	2.15	18.63	37.17
T ₆ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> propaquizafop 62.5 g ha ⁻¹ at 40 DATP	0.91	2.30	23.87	40.93
T ₇ : Pendimethalin 0.625 kg ha ⁻¹ as PPI <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	0.80	2.17	11.71	31.48
T ₈ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	0.76	1.23	9.93	19.57
T ₉ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	0.59	1.16	9.03	16.42
T ₁₀ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	0.42	1.00	7.61	14.00
T ₁₁ : Pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ as PoE at 30 DATP	1.54	2.69	35.92	46.67
T ₁₂ : Pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ as PoE at 30 DATP	1.59	3.02	38.46	53.00
T ₁₃ : Weed free check	0.00	0.36	1.10	3.22
T ₁₄ : Unweeded check	2.21	32.17	95.33	120.33
S.Em.±	0.12	0.44	1.88	3.14
C.D. at 5%	0.36	1.27	5.45	9.13
C.V.%	23.96	18.53	14.26	15.34

B. Effect on dry weight of total weeds

An analysis of the data showed that the diverse weed control strategies had a notable impact on dry weight of total weeds. Among the different weed management treatments, the weed free check (T₁₃) recorded significantly lowest dry weight of total weeds at 20, 40, 60 DATP and at harvest, The next superior treatments in this regard was tank-mix pendimethalin

Commented [k8]: weeds (Table 2)

0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* HW at 40 DATP (T₃) and tank-mix pendimethalin 0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha at 40 DATP (T₁₀). Whereas, highest dry weight of total weeds at 20, 40, 60 DATP and at harvest was recorded under the unweeded check (T₁₄). These outcomes resemble those published by Angmo and Chopra (2020), Jagadeesha *et al.* (2020), Sahu *et al.* (2020).

Table 3: Effect of different weed management treatments on various weed indices

Treatments	WI/WCI (%)	WCE (%)	HEI
T ₁ : Pendimethalin 0.90 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	9.73	78.47	2.27
T ₂ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	16.09	75.07	1.80
T ₃ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	2.69	88.39	4.52
T ₄ : Oxadiargyl 75 g ha ⁻¹ as early PoE at 7 DAS <i>fb</i> HW at 40 DATP	21.90	67.99	1.27
T ₅ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> quizalofop 40 g ha ⁻¹ at 40 DATP	15.51	70.25	1.52
T ₆ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> propaquizafop 62.5 g ha ⁻¹ at 40 DATP	15.49	66.01	1.33
T ₇ : Pendimethalin 0.625 kg ha ⁻¹ as PPI <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	14.79	75.07	1.83
T ₈ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	8.51	84.42	3.17
T ₉ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	9.58	86.97	3.75
T ₁₀ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	4.33	87.82	4.24
T ₁₁ : Pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ as PoE at 30 DATP	22.16	60.91	1.04
T ₁₂ : Pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ as PoE at 30 DATP	20.50	56.09	0.95
T ₁₃ : Weed free check	0.00	97.93	-

T ₁₄ : Unweeded check	53.77	0.00	-
----------------------------------	-------	------	---

WI/ WCI: Weed Index/ Weed Competition Index, WCE: Weed Control Efficiency,

HEI: Herbicidal Efficiency Index

Table 4: Effect of distinct weed management treatments on various weed indices

Treatments	CRI	WPI	WMI	AMI	IWMI
T ₁ : Pendimethalin 0.90 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	9.43	0.94	1.21	0.21	0.71
T ₂ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	7.53	0.91	1.09	0.09	0.59
T ₃ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> HW at 40 DATP	18.76	0.78	1.25	0.25	0.75
T ₄ : Oxadiargyl 75 g ha ⁻¹ as early PoE at 7 DAS <i>fb</i> HW at 40 DATP	5.47	1.15	1.01	0.01	0.51
T ₅ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> quizalofop 40 g ha ⁻¹ at 40 DATP	6.36	1.02	1.18	0.18	0.68
T ₆ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> propaquizafop 62.5 g ha ⁻¹ at 40 DATP	5.57	1.03	1.25	0.25	0.75
T ₇ : Pendimethalin 0.625 kg ha ⁻¹ as PPI <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	7.69	1.03	1.12	0.12	0.62
T ₈ : Oxyfluorfen 0.24 kg ha ⁻¹ as PPI <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	13.22	0.90	1.16	0.16	0.66
T ₉ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ at 40 DATP	15.58	0.78	1.10	0.10	0.60
T ₁₀ : Tank-mix pendimethalin 0.45 kg ha ⁻¹ + oxyfluorfen 0.12 kg ha ⁻¹ as PPI <i>fb</i> pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ at 40 DATP	17.56	0.93	1.22	0.22	0.72
T ₁₁ : Pre-mix quizalofop + oxyfluorfen 100 g ha ⁻¹ as PoE at 30 DATP	4.48	0.90	1.12	0.12	0.62
T ₁₂ : Pre-mix propaquizafop + oxyfluorfen 43.75+105 g ha ⁻¹ as PoE at 30 DATP	4.05	0.94	1.28	0.28	0.78
T ₁₃ : Weed free check	108.62	0.33	1.19	0.19	0.69

T ₁₄ : Unweeded check	1.00	1.00	-	-	-
----------------------------------	------	------	---	---	---

CRI: Crop Resistance Index, WPI: Weed Persistence Index, WMI: Weed Management Index
AMI: Agronomic Management Index, IWMI: Integrated Weed Management Index

C. Effect on weed indices

A data revealed that many weed control techniques had a substantial impact on the weed indices. Besides the treatment weed free check, lower WI/WCI was recorded in tank-mix pendimethalin 0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* HW at 40 DATP and higher WCE was noted under tank-mix pendimethalin 0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha at 40 DATP. Among the different herbicidal treatments, higher HEI was registered under tank-mix pendimethalin 0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* HW at 40 DATP. The higher WPI was observed under oxadiargyl 75 g/ha as early post-emergence at 15 DATP *fb* HW at 40 DATP and higher CRI was recorded under weed free check. The higher WMI, AMI and IWMI were higher under pre-mix quizalofop + oxyfluorfen 100 g/ha as post planting at 30 DATP followed by tank-mix pendimethalin 0.45 kg/ha + oxyfluorfen 0.12 kg/ha as pre-planting *fb* HW at 40 DATP. The current results are in similar proximity to those that have been documented with other weed control methods by Thakare *et al.* (2018), Pushpa and Choudhary (2019), Tripathy *et al.* (2019), Swati *et al.* (2020).

CONCLUSIONS

Based on finding, it can be concluded that effective control of complex weed flora with profitable production of onion can be achieved by application of tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* HW at 40 DATP, tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* pre-mix propaquizafop + oxyfluorfen 43.75+105 g/ha at 40 DATP and tank-mix pendimethalin 450 g/ha + oxyfluorfen 120 g/ha as pre-planting *fb* pre-mix quizalofop + oxyfluorfen 100 g/ha at 40 DATP.

Commented [k9]: How to determine these variables CRI, WPI, WMI, AMI, IWMI, WI, WCI, WCE, and HEI must be explained in Materials and Methods.

Commented [k10]: (Table 3 and 4).

REFERENCES

- Angmo, D. and Chopra, S. 2020. Comparative efficacy of herbicides and hand weeding to control weeds in onion. *Indian Journal of Weed Science*, **52**(1): 53-57.
- Jagadeesha, N., Srinivasulu, G. B., Venkatesh, H., Ravikumar, B. and Lingamurthy, K. R. 2020. Effect of pre and post emergence herbicide for weed management in onion bulb yield in northern dry zone of Karnataka, India. *International Journal of Current Microbiology and Applied Science*, **9**(2): 1893-1898.
- Kalhpure, A., Shete, B. and Dhonde, M. 2014. Weed management in onion by pre-planting and post-emergence herbicides for seed production. *Indian Journal of Weed Science*, **46**: 142-45.
- Perane, R. R. 2001. Studies on purple blight of onion caused by *Alternaria cepuleculi* with special reference to toxin production. Ph.D. Thesis (Unpublished), Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar, M.S. (India).
- Pushpa, U. and Chaudhary, M. R. 2019. Effect of weed management treatments on weed count, weed dry matter and bulb yield of onion under varying levels of nitrogen. *Journal of Pharmacognosy and Phytochemistry*, **8**(3): 1145-1147.
- Rahman, M. A., Mahmud, J. A. and Islam, M. M. 2013. Influence of mulching on the growth and yield of onion. *Technical Journal of Engineering and Applied Sciences*, **3**(24): 3497-3501.
- Rakesh, K. and Pramod, K. 2021. Evaluation of oxyfluorfen and quizalofop-ethyl weedicides for weed control in onion (*Allium cepa*). *Current Horticulture*, **9**(2): 60-63.
- Ramalingam, S. P., Chinnappagounder, C., Perumal, M. and Palanisamy, M. A. 2013. Evaluation of new formulation of oxyfluorfen (23.5% EC) for weed control efficacy and bulb yield in onion. *American Journal of Plant Sciences*, **4**: 890-895.
- Sahu, M. R., Ashirbachan, M. and Madan, K. J. 2020. Effect of different weed management practices on onion (*Allium cepa* L.). *The Pharma Innovation Journal*, **9**(4): 170-175.
- Sinare, R. T., Andhale, R. P. and Gautam, M. 2014. Weed control in onion with herbicides. *Indian Journal of Weed Science*, **46**(2): 192-194.

- Stall, W. O. and Gilreath, J. P. 2002. Estimation effectiveness of recommended herbicides on selected common weeds in Florida vegetables. *Weed Management in Florida Fruits and Vegetables*, Gainesville, pp. 59-64.
- Swati, B. and Kirad, K. S. 2020. Efficacy of herbicides on weed growth and bulb yield in onion. *International Journal of Agricultural Sciences*, **1**: 218-222.
- Tewari, A. N., Tiwari, S. N., Rathi, J. P., Singh, B. and Tripathi, A. K. 2003. Studies on crop-weed competition in *kharif* onion (*Allium cepa* L.). *Indian Journal of Weed Science*, **35**(1-2): 156-158.
- Thakare, S., Chirde, P. N., Deshmukh, J. P., Kakade, S. U., Shingrup, P. V. and Gholap, A. N. 2018. Weed Management in onion by pre and post-emergence herbicide. *International Journal of Current Microbiology and Applied Sciences*, **6**: 2197-2202.
- Tripathy, P., Sahoo, B. B., Patel, D. and Dash, D. K. 2019. Weed management studies in onion (*Allium cepa* L.). *Journal of Crop and Weed*, **9**(2): 210-212.
- Udit, K. 2014. Weed management studies in onion (*Allium cepa* L.). *Asian Journal of Horticulture*, **9**(2): 426-430.
- Upadhyay, V. B., Singh, A. and Rawat, A. 2013. Efficacy of early post emergence herbicides against association weeds in soybean. *Indian Journal of Agronomy*, **44**(4):73-75.