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# Evaluation of Pre and Post Emergence Herbicides on Yield Contributing and Quality Characters in Onion cv. N-53

**M. Venkateswara Reddy*, K. Umajyothi, P. Syam Sundar Reddy and K. Sasikala**

College of Horticulture and Research Institute, Venkataramannagudem, West Godavari (Dt)-534 101.

Dr. YSR Horticultura University

*Corresponding Author E-mail: reddymanukonda1973@gmail.com

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**ABSTRACT**

*A field experiment was conducted to find out best weed management practices in onion (Allium cepa L.,) during rabi 2011-12 and 2012-13. The experiment was laid out in Randomized block design with three replications. The experiment consisted of pendimethalin, oxyflourfen as pre emergence herbicides and Imazethapyr and Quizalofop ethyl as post emergence herbicides and their combination thus forms 10 treatments along with Weedy check. Application of pendimethalin and oxyflourfen supplemented with Quizalofop ethyl @ 75 g a.i / ha as post emergence found to be on par with hand weeding thrice on yield contributing characters like Bulb diameter, Neck diameter, Bulb length, Average bulb weight and Bulb yield. Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT ) coupled with pre emergence herbicides produced the lower values than weedy check ($T_{10}$) as Imazethapyr found to be toxic to the Onion.*

***Key words:*** *Onion, Bulb, Vegetable, Vitamin-C*

## INTRODUCTION

Onion (*Allium cepa* L.) is an important bulbous vegetable crop grown in the world after tomatoes and is considered as top most export commodity among vegetables. Onion bulb is rich in minerals, especially calcium and phosphorus besides having fairly good quantities of carbohydrates, proteins and vitamin-C. It forms an indispensable part of many diets of both vegetarian and non-vegetarian as a flavouring agent. It is consumed in raw form and salads regularly in small quantities comparable with that of hot pepper. The outstanding characteristics of onion are the pungency, which is due to a volatile compound known as "Allyl-propyl disulphide", which is sulphur rich compound. It has got the effects of lowering the blood sugar fat and also having good coagulation effect. Because of its importance in cookery, onion is called "queen of the kitchen" by germans.[14]

At present, the production share of onion is 10.4 per cent of the total vegetable production with 11.4 per cent of total vegetable area in the country. In India, onion was grown on an area of 10.5 lak hectares with a production of 168.1 lak tonnes and the productivity is 16 tonnes per hectare.

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The major onion producing states are Maharashtra, Karnataka, Gujarat, Bihar, Madhya Pradesh, Andhra Pradesh, Rajasthan and Haryana. Andhra Pradesh occupies 6th place in onion production. Andhra Pradesh covers an area of 0.8667 lakh hectares with a production of 15.60 lakh tonnes and the average productivity is 18tonnes per hectare. Onion accounts 9 percent of total vegetable production in A.P.[5]

Among many causes of low productivity, onion exhibits greater susceptibility to weed competition as compared to other crops due to its inherent characteristics such as slow germination, extremely slow growth in the initial stages, short stature, non-branching habit, sparse foliage and shallow root system. This favours quick and fast growth of weeds in the initial stages and competition thus tends to be severe. Moreover, use of liberal dose of FYM, fertilizers and frequent irrigations creates favourable conditions for weed growth[10]. It is an established fact that weeds compete with crop plants for space, nutrients, moisture and light there by reducing the quality and quantity of yield[7]. If the weeds are present throughout the crop growth period, there may be complete loss of marketable yield. The reduction in bulb yield varies to the extent of 48 to 85 per cent depending upon the duration, intensity of weed growth and weed competition[4]. Hand weeding in onion is a common practice in India, but it is a tedious expensive and time consuming task due to closer spacing and shallow root system. Non-availability of labour during critical period of crop makes hand weeding difficult leading to heavy yield losses. The critical period of crop-weed competition in onion lies between 15-60 days after transplanting[13]. Hence, managing the weeds meticulously in early stages is an imperative task to get bulb yield. Hence, this is imperative need to evaluate suitable herbicides for weed control in combination with manual weeding in onion. Keeping the above mentioned facts, the present investigation was under taken to find out best combinations of herbicides for effective weed control and bulb yield in Onion.

## MATERIAL AND METHODS

An experiment was conducted at Horticultural college and Research Institute, Dr.Y.S.R Horticultural University, Venkataram-annagudem, Tadepalligudem, West Godavari District, A.P during Rabi season of 2011-12 and 2012-13. The soil was acidic in reaction and medium in NPK availability. The texture of the soil was sandy loam. The experiment was laid out in Randomised block design with three replications in a plot size of 4X3 $m^2$.

The seeds of onion cultivar "N-53" was sown for nursery raising and transplanting was done on ridge and furrow system by adopting spacing of 30X10 cm. The ten treatments consists of $T_1$- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application, $T_2$- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application, $T_3$- Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT ), $T_4$- Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), $T_5$- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application + Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT ), $T_6$- Pendimethalin @ 0.75 Kg a.i / ha as pre emergence application+ Imazethapyr @ 100 g a.i / ha as post emergence application (20 DAT ), $T_7$- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), $T_8$- Oxyfluorfen @ 0.125 Kg a.i / ha as pre emergence application + Quizalofop ethyl @ 75 g a.i / ha as post emergence application (20 DAT), $T_9$- Weed free (Hand weeding) and $T_{10}$- Weedy check.

Forty five days old seedlings were used for transplanting. Upper one third portions of the seedlings were removed at the time of transplanting to reduce the transpiration loss and better establishment of crop. All the package of practices to raise the good crop was done in the experimental field and weed control treatments applied as per the treatments.

## RESULTS AND DISCUSSION

### Yield attributing characters

**Bulb length (cm)**

The data on bulb length was presented in the Table-1. Maximum value for bulb length was recorded with T9 (weed free -hand weeding at 20, 40, 60 DAT), which remain statistically on par with T6 (Pendimethalin @ 0.75 kg a.i/ha + Quizalofop ethyl @ 75g a.i/ha as POE) and T8 (Oxyfluorfen @ 0.125 kg a.i/ha as PE + Quizalofop ethyl @ 75g a.i/ha as POE). Imazethapyr @ 60g a.i/ha as POE treated plots (T3, T5and T7) recorded lower values than T10 (weedy check).The treatments (T1 and T2) applied with pre emergence herbicides Pendimethalin @ 0.75 kg a.i/ha and Oxyfluorfen @ 0.125 kg a.i/ha found to be equally effective on bulb length.

**Neck diameter (cm)**

The data on neck diameter are presented in the Table-1. During both the years, higher values for neck diameter were recorded in T9, which was equal to T6, T8, T1 and T2. The plots (T3, T5 and T7) applied with Imazethapyr @ 60g a.i/ha as POE produced lower values than T10 (weedy check).

**Bulb diameter (cm)**

The data on bulb diameter are presented in the Table-1. Maximum values for bulb diameter were observed in T9, which were found to be on par with T6, T8, T1 and T2 treatments. However treatments (T3, T5 and T7) applied with Imazethapyr @ 60g a.i/ha as POE produced lower values than T10 (weedy check). Similar trend was observed in both the years. Similar results have been reported by Warade *et al.*[15], Nadagouda[8] and Vashi *et al.*[14].

**Average bulb weight (g)**

The data on average bulb weight are presented in the Table-2. Highest bulb weight was recorded in T9 (weed free -hand weeding at 20, 40 and 60 DAT) with significant disparity over any other treatment, whereas T6 (Pendimethalin @ 0.75 kg a.i/ha + Quizalofop ethyl @ 75g a.i/ha as POE) and T8 (Oxyfluorfen @ 0.125 kg a.i/ha as PE + Quizalofop ethyl @ 75g a.i/ha as POE) treatments registered next to T9 (weed free - hand weeding at 20, 40, 60 DAT) and remain on par with each other in bulb weight. Imazethapyr @ 60g a.i/ha as POE treated plots (T3, T5 and T7) recorded lower values than T10 (weedy check). The results of yield contributing factors revealed that, significantly highest bulb weight, bulb length, bulbdiameter and neck diameter were recorded in the treatment T9 (weed free -hand weeding at 20, 40 and 60 DAT) followed by T6 (Pendimethalin @ 0.75 kg a.i/ha + Quizalofop ethyl @ 75g a.i/ha as POE) and T8 (Oxyfluorfen @ 0.125 kg a.i/ha as PE + Quizalofop ethyl @ 75g a.i/ha as POE) in both the years.

The superiority of all of these yield attributing characters such as Bulb diameter, Neck diameter, Bulb length and average bulb weight inT9 (weed free -hand weeding at 20, 40, 60 DAT) (or) T6 (Pendimethalin @ 0.75 kg a.i/ha + Quizalofop ethyl @ 75g a.i/ha as POE) orT8 (Oxyfluorfen @ 0.125 kg a.i/ha (PE) + Quizalofop ethyl @ 75g a.i/ha as POE) may be due to timely and effective control of broad spectrum of weeds in the critical stage of competition which reduces crop-weed competition for space, light, moisture and nutrients which ultimately created congenial conditions for the crop, especially nutrients, which accelerate the production of photosynthates and their translocations to sink.

**Bulb yield (t/ha)**

All the weed control treatments significantly effected the bulb yield in both the years of experiments and the data are presented in Table-2. T9 (Weed free hand weeding at 20, 40 and 60 DAT) produced the maximum bulb yield to the tune of 18.89 tonnes/ha and 19.19 t/ha during first and second year respectively. In both the years, T9 (hand weeding at 20, 40 and 60DAT) produced the highest yield followed by T6 (Pendimethalin @ 0.75 kg a.i/ha (PE) + Quizalofop ethyl @ 75g a.i/ha as POE). T1 (Pendimethalin @ 0.75 kg a.i/ha) and T2 (Oxyfluorfen @ 0.125 kg a.i/ha) treatments applied aspre emergence herbicides were comparable to each other, but were inferior to T6 (Pendimethalin @ 0.75 kg a.i/ha (PE) + Quizalofop ethyl @ 75g a.i/ha as POE) and T8 (Oxyfluorfen @ 0.125 kg a.i/ha+ Quizalofop ethyl @ 75g a.i/ha as POE).

Owing to phytotoxic effect, Imazethapyr @ 60g a.i/ha (T3), T5 (Pendimethalin @ 0.75 kg a.i / ha as PE +

Imazethapyr @ 60 g a.i / ha as POE) and T7 (Oxyfluorfen @ 0.125 kg a.i / ha as PE + Imazethapyr @ 60 g a.i / ha as POE) produced the lowest bulb yield of onion. The highest bulb yield obtained in T9 (weed free-hand weeding at 20, 40, 60 DAT) is comparable to T6 (Pendimethalin @ 0.75 kg a.i/ha (PE) + Quizalofop ethyl @75g a.i/ha as POE) and T8 (Oxyfluorfen @ 0.125kg a.i/ha (PE) +Quizalofop ethyl @ 75g a.i/ha as POE). This is because of the fact that the weed population and weed growth remain low from initial crop growth as compared to T10 (weedy check).

The reduced crop-weed competition provide better environment for proper growth and development and bulb yield. This might be due to proper weed management treatments which controlled weeds effectively, reduced the competition from the weeds to a greater extent and thus helped in faster growth and development of onion bulb crop, resulting in higher values of all yield attributing characters, which are positively correlated with yield. The findings are in closely vicinity of those reported by Warade *et al.*[16], Saraf[12], Vashi *et al.*[14], Patel *et al.*[9] and Sangeetha Kumari and Singh[11].

**Quality parameters of onion as influenced by different weed management practices**

**Total soluble solids (%)**

The total soluble solids in onion bulbs were not significantly influenced by weed management practices (Table-2). The range of TSS varied from 10.34 to 11.56 and 10.25 to 11.85 respectively during both the years. Similar results were also reported by Anita Singh *et al.*[1], Balraj Singh[3] and Arte[2].

**Sprouting (%)**

Sprouting percentage in onion bulbs did not differ significantly due to weed management practices at 60 90 and 120 days after harvesting (Table-3). However low sprouting of bulbs was recorded in T9 treatment at 90 DAH and 120 DAH, whereas at 60 DAH, lower sprouting of bulbs was observed with T6 (Pendimethalin @ 0.75kg a.i/ha as PE coupled with Quizalofop ethyl @ 75g a.i/ha).

**Rotting (%)**

The rotting percentage in onion bulbs at 60, 90 and 120 days after harvesting did not differ significantly due to different weed management practices (Table 4). These results corroborate the findings of Arte[2] and Manjunatha[6].

**Table-1 Bulb diameter (cm), Neck diameter (cm) and Bulb length (cm) of Onion as influenced by weed management practices**

| | Treatment | Bulb diameter (cm) | | Neck diameter (Cm) | | Bulb length (cm) | |
|---|---|---|---|---|---|---|---|
| | | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| $T_1$ | Pendimethalin @ 0.75 kg a.i / ha as PE | 6.65 | 6.49 | 1.91 | 1.89 | 5.42 | 5.51 |
| $T_2$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE | 6.46 | 6.38 | 1.88 | 1.83 | 5.25 | 5.36 |
| $T_3$ | Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 3.92 | 4.68 | 1.14 | 1.18 | 2.20 | 3.62 |
| $T_4$ | Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 6.24 | 6.31 | 1.85 | 1.80 | 5.13 | 5.17 |
| $T_5$ | Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 4.54 | 5.25 | 1.33 | 1.30 | 3.93 | 4.18 |
| $T_6$ | Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 6.97 | 6.57 | 1.93 | 2.00 | 5.95 | 6.60 |
| $T_7$ | Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 4.02 | 4.85 | 1.21 | 1.27 | 3.77 | 3.74 |
| $T_8$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 6.77 | 6.55 | 1.92 | 1.95 | 5.59 | 6.33 |
| $T_9$ | Weed free (Hand weeding at 20, 40 and 60 DAT) | 7.09 | 6.91 | 2.16 | 2.01 | 6.24 | 6.81 |
| $T_{10}$ | Weedy Check | 5.86 | 5.94 | 1.76 | 1.74 | 5.00 | 5.25 |
| | | | | | | | |
| | S.Em± | 0.28 | 0.26 | 0.14 | 0.14 | 0.25 | 0.42 |
| | CD (P=0.05) | 0.85 | 0.77 | 0.42 | 0.42 | 0.74 | 1.24 |

PE- Pre emergence POE- Post emergence

DAT- Days after transplanting

**Table-2 Bulb weight (g), Bulb yield (t/ha) and TSS (%) of Onion as influenced by weed management practices**

| | Treatment | Average Bulb weight (g) | | Bulb yield (t/ha) | | TSS (%) | |
|---|---|---|---|---|---|---|---|
| | | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| $T_1$ | Pendimethalin @ 0.75 kg a.i / ha as PE | 125.60 | 124.00 | 14.42 | 15.78 | 10.62 | 10.76 |
| $T_2$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE | 110.80 | 112.04 | 13.64 | 14.92 | 10.67 | 10.84 |
| $T_3$ | Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 30.67 | 41.81 | 0.54 | 0.63 | 10.53 | 10.25 |
| $T_4$ | Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 99.47 | 101.17 | 11.50 | 12.63 | 10.63 | 11.27 |
| $T_5$ | Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 41.13 | 47.90 | 0.70 | 0.77 | 10.48 | 10.53 |
| $T_6$ | Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 129.11 | 131.25 | 17.75 | 18.29 | 11.56 | 11.85 |
| $T_7$ | Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 33.24 | 38.91 | 1.04 | 0.88 | 10.34 | 10.61 |
| $T_8$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 126.80 | 125.60 | 16.87 | 17.64 | 11.35 | 11.64 |
| $T_9$ | Weed free (Hand weeding at 20, 40 and 60 DAT) | 147.20 | 150.13 | 18.89 | 19.67 | 11.28 | 11.57 |
| $T_{10}$ | Weedy Check | 90.63 | 93.61 | 6.65 | 7.92 | 10.37 | 10.32 |
| | | | | | | | |
| | S.Em+ | 4.64 | 7.37 | 1.00 | 1.06 | 0.75 | 0.83 |
| | CD (P=0.05) | 13.88 | 22.07 | 2.99 | 3.17 | N.S. | N.S. |

**Table-3 Sprouting (%) of Onion bulbs as influenced by weed management practices**

| | Treatment | 60 DAH | | 90 DAH | | 120 DAH | |
|---|---|---|---|---|---|---|---|
| | | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| $T_1$ | Pendimethalin @ 0.75 kg a.i / ha as PE | 8.36 | 8.56 | 15.48 | 16.26 | 23.54 | 23.69 |
| $T_2$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE | 8.47 | 8.64 | 16.27 | 16.84 | 24.67 | 24.56 |
| $T_3$ | Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 9.12 | 9.48 | 17.35 | 17.85 | 25.24 | 25.25 |
| $T_4$ | Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 8.25 | 8.52 | 15.26 | 15.76 | 22.36 | 22.67 |
| $T_5$ | Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 9.56 | 9.75 | 16.46 | 16.85 | 24.83 | 24.95 |
| $T_6$ | Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 8.12 | 8.43 | 15.18 | 15.37 | 23.18 | 23.25 |
| $T_7$ | Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 9.75 | 9.86 | 16.18 | 16.28 | 25.48 | 25.64 |
| $T_8$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 8.54 | 8.75 | 15.54 | 15.73 | 22.68 | 22.75 |
| $T_9$ | Weed free (Hand weeding at 20, 40 and 60 DAT) | 8.65 | 8.86 | 14.78 | 15.15 | 22.75 | 23.45 |
| $T_{10}$ | Weedy Check | 8.76 | 8.94 | 15.12 | 15.28 | 23.75 | 24.15 |
| | | | | | | | |
| | S.Em+ | 0.52 | 0.71 | 1.2 | 1.05 | 1.42 | 1.25 |
| | CD (P=0.05) | NS | NS | NS | NS | NS | NS |

**Table-4 Rotting (%) of Onion bulbs as influenced by weed management practices**

| | Treatment | 60 DAH | | 90 DAH | | 120 DAH | |
|---|---|---|---|---|---|---|---|
| | | 2011-12 | 2012-13 | 2011-12 | 2012-13 | 2011-12 | 2012-13 |
| $T_1$ | Pendimethalin @ 0.75 kg a.i / ha as PE | 17.83 | 17.85 | 21.36 | 21.75 | 24.24 | 25.36 |
| $T_2$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE | 18.26 | 18.56 | 21.73 | 21.95 | 23.75 | 24.15 |
| $T_3$ | Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 19.37 | 18.73 | 22.68 | 22.86 | 25.18 | 26.42 |
| $T_4$ | Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 17.83 | 17.52 | 21.24 | 21.25 | 22.48 | 23.25 |
| $T_5$ | Pendimethalin @ 0.75 kg a.i / ha as PE +Imazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 20.43 | 20.57 | 23.21 | 23.52 | 25.53 | 26.67 |
| $T_6$ | Pendimethalin @ 0.75 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 17.38 | 17.25 | 21.16 | 21.43 | 24.56 | 23.15 |
| $T_7$ | Oxyfluorfen @ 0.125 kg a.i / ha as PEImazethapyr @ 60 g a.i / ha as POE (20 DAT ) | 19.65 | 19.56 | 22.15 | 22.52 | 25.76 | 27.46 |
| $T_8$ | Oxyfluorfen @ 0.125 kg a.i / ha as PE + Quizalofop ethyl @ 75 g a.i / ha as POE (20 DAT) | 18.37 | 18.25 | 20.83 | 21.12 | 24.18 | 24.72 |
| $T_9$ | Weed free (Hand weeding at 20, 40 and 60 DAT) | 18.54 | 17.35 | 20.42 | 20.45 | 23.65 | 23.68 |
| $T_{10}$ | Weedy Check | 21.35 | 21.26 | 22.53 | 23.16 | 24.58 | 24.86 |
| | | | | | | | |
| | S.Em± | 1.39 | 1.60 | 1.28 | 1.57 | 1.43 | 1.47 |
| | CD (P=0.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |

## REFERENCES


1. Singh, A., Sachan, D. N., Singh, A. R. and Singh, A., Effect of different weedicides on quality of onion (*Allium cepa*.L).under varying levels of nitrogen application. *New Agriculturist*. **3(1):** 7-12 (1992).
2. Atre, S., Chemical weed control in onion.*M.Sc. (Agri.) Thesis*, *University of Agricultural sciences*, Dharwad (2001).
3. Singh, B., Studies on weed control in onion.*vegetable science*. **23(1):** 30-35 (1996).
4. Bhalla, P. L., Weed competition, crop losses and chemical weed control in onion – A Review. *Pestology*. **11(2):** 35-39 (1978).
5. Indian horticulture database. www.nhb.gov.in (2013).
6. Manjunatha, R., Integrated weed management in transplanted onion (*Allium cepa*l.) under irrigated alfisol. *M.Sc. (Agri.) Thesis*, *University of Agricultural Sciences*, Dharwad (2005).
7. Moolani, M. K. and Sachan, P. L., Studies on crop weed competition – A Review, *Indian J. Agronomy*. **11:** 372-77 (1966).
8. Nadagouda, B. T., Integrated weed management in drill sown onion (*Allium cepa*L.). *M.Sc. (Agri.) Thesis*, *University of Agricultural Sciences*, Dharwad (1995).
9. Patel, T. U., Patel, C. L., Patel, D. D., Thanki, J. D., Arvadia, M. K. and Vaidya, H. B., Performance of onion under weed and fertilizer management. *Indian Journal of weed science*. **44(3):** 151-58 (2012).
10. Singh, R., Sinha, K. P. and Singh, S. P., Comparative efficacy of herbicides and hand weeding for the control of weeds in onion. *Haryana Journal of Horticultural Sciences.* **15:** 76-82 (1986).
11. Kumari, S. and Singh, S. P., Bulb yield and nutrient uptake by onion as affected by weed control. *Indian Journal of Horticulture.* **69(4):** 594-97 (2012).
12. Saraf, R. K., Herbicidal weed control in kharif onion. *Asian journal of Horticultural Science* **2(1):** 1-5 (2007).
13. Singh, M. P. and Singh K. P., Effect of crop weed competition on growth and yield of Kharifonion.*Indian Journal of Weed Science*. **26:** 18-21 (1994).
14. Vashi, J. M., Patel, N. K. and Desai, D. T., Evaluation of different herbicides for controlling weeds in onion (*Allium cepa* L.). *Vegetable Science*. **38(1):** 119-20 (2011).

15. Warade, S. D., Desale, S. B. and Shinde, K. G., Effects of weedicides on weed intensity and yield of kharif onion cv. Phulesafed. *Journal of Maharashtra Agricultural Universities*. **2(1):** 48-49 (1995).

16. Warade, A. D., Gonge, V. S., Jog Dande, N. D., Ingole, P. G. and Karunakar, A. P., Integrated weed management in onion. *Indian Journal of weed science.* **38(1&2):** 92-95 (2006).