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# Effect of methods of sowing and weed management practices on growth and yield of chicory (*Cichorium intybus* L.)

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**Abstract**
A field experiment was conducted during *rabi* season during the year 2017-18 at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat to study the effect of methods of sowing and weed management practices on productivity of chicory (*Cichorium intybus* L.). This experiment was laid out in a randomized block design with four replications. The results revealed that the significantly higher plant population was recorded under broadcasting and root volume was also recorded higher under line sowing. Among different weed management practices, plant population, root volume, fresh root yield and dry root yield of chicory were recorded significantly higher under treatment of Pendimethalin @ 0.500 kg ha$^{-1}$ as pre-emergence *fb* HW 30 DAS. The number of leaves plant$^{-1}$ does not influence by any of factor studied. Combined effect of methods of sowing and weed management practices brought out significant variation in fresh root yield, dry root yield and weed index of chicory.

**Keywords:** Chicory, methods of sowing, weed management practices

## Introduction
Chicory (*Cichorium intybus* L.) belonging to family *Asteraceae* is an important cash crop with a fleshy tap root. It is hardy perennial herb grown as biennial crop and has been introduced in India from Mediterranean region. It is by nature a temperate climate crop and first used as a beverage by Europeans in the seventeenth century. Chicory roots are roasted and, used in powder form for blending with coffee. Chicory powder not only increases the bulk, but also provides deep aroma and taste, increases the keeping quality of coffee and is considered a useful improver of pure coffee. In Indian medicine, it used as tonic, against fever, vomiting, diarrhea and enlargement of the spleen. Chicory roots contain polyfructose an insulin on storage with carbohydrates having glucose and fructose as the structural unit In view of the importance of chicory to the coffee industry, the Government of India have fixed the upper limit of mixing chicory (49 percent).The important chicory growing districts in Gujarat are Kheda, Anand, Jamnagar and Mahsana. The overall area under this crop in Anand during the year of 2015-16 was 656 hectares, and the productivity during this year was 12.09 t ha$^{-1}$, respectively (Anon., 2016) [1]. Chicory occupies a place of pride amongst the *rabi* cash crop in Anand district. The major weeds present in chicory crop are Chill (*Chenopodium album*), Amaranthus (*Digera arvensis*), Satodi (*Boerhavia diffusa*), Nettle leaf (*Chenopodium murale*), Chidho (*Cyperus rotundus*), Crabgrass (*Digitaria adscendens*), Indian love grass (*Eragrostis tenella*). Chicory crop germinates relatively slow, so it is susceptible to weed competition at a very early stage in its life cycle, leading to reduction in the yield of the crop. Ravikumar (1972) [8] reported that 51.00 per cent reduction in dry root yields in unweeded control as compared to weed free check.Chicory is generally sown by broadcasting method. Hand weeding is the major practices for weed control; therefore possibility of line sowing was exploited in experiment. In 20 cm (high seed rate) spacing between plant competition did not allow roots to flourish, whereas in 30 cm (lower seed rate) as the distance between two plants (within row) was wider it helped in avoiding competition. Thus line sowing is possible and farmers may adopt 30 cm distance between rows (Mehta *et al.*, 1995) [3]. Use of herbicides is also associated with certain limitations. They provide weed control during the earlier part of the crop season but weed flushes appearing at later stages reduce the quality and yield of chicory roots. Under this situation, if we supplement herbicide with one weeding, it may be

helpful in increasing yield of crops by checking weeds at later stage and also by creating the proper atmosphere for root development.

## Materials and Methods

The experiment was carried out in *rabi* season during the year 2017-18 at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand. The experimental site had an even topography with moderate slope and good drainage and the soil is representative of the soils of the region, popularly known as "*Goradu*" soil. It is alluvial in origin. The soils are very deep and fairly moisture retentive. Data on soil analysis indicated that the experimental site was low in organic carbon (0.26 %) and available nitrogen (172.50 kg ha$^{-1}$), while medium in available phosphorus (28.75 kg ha$^{-1}$) and potassium (215.21 kg ha$^{-1}$). Nitrogen was estimated by Modified Micro Kjeldahl's (Piper, 1996) [6], phosphorus by Vanado Molybdate Phosphoric Acid Method (Jackson, 1973) [2] and potassium by Flame Photometer Method (Jackson, 1973) [2]. The maximum temperature ranged between 25.5 to 40.3˚C and minimum temperature ranged between 9.3 to 21.6˚C during the crop season. The average humidity was ranged between 39.8 to 76.8 per cent, during the crop season. Twelve treatment combinations comprising two methods of sowing and six weed management practices were embedded in randomized block design with four replications included in the experiment. The details of the treatments are given under.

**Treatment details**

**Treatments: 12 (Combination of M and W)**

**Methods of Sowing(M)**

**M$_1$**: Broadcasting**M$_2$**: Line sowing (30 cm)

**Weed Management Practices(W)**

**W$_1$**:Pendimethalin @ 0.500 g ha$^{-1}$pre-emergence

**W$_2$**: 2. Metribuzin @ 0.400 gha-1 pre-emergence

**W$_3$**:Pendimethalin @ 0.500 g ha$^{-1}$pre-emergence *fb* HW 30 DAS

**W$_4$**: Metribuzin @ 0.400 g ha$^{-1}$ pre-emergence *fb* HW 30 DAS

**W$_5$**: 5. Hand weeding at 30 and 45 DAS

**W$_6$:** Weedy check

**Treatment combination: 12**

T$_1$ Broadcasting + Pendimethalin @ 0.500kg ha$^{-1}$ pre-emergence M$_1$W$_1$

T$_2$ Broadcasting + Metribuzin @ 0.400kg ha$^{-1}$ pre-emergence M$_1$W$_2$

T$_3$ Broadcasting + Pendimethalin @ 0.500kg ha$^{-1}$ pre-emergence *fb* HW 30 DAS M$_1$W$_3$

T$_4$ Broadcasting + Metribuzin @ 0.400kg ha$^{-1}$ pre-emergence *fb* HW 30 DAS M$_1$W$_4$

T$_5$ Broadcasting + Hand weeding at 30 and 45 DAS M$_1$W$_5$

T$_6$ Broadcasting+ Weedy check M$_1$W$_6$

T$_7$ Line sowing (30 cm) +Pendimethalin @ 0.500kg ha$^{-1}$ pre-emergence M$_2$W$_1$

T$_8$ Line sowing (30 cm) + Metribuzin @ 0.400kg ha$^{-1}$ pre-emergence M$_2$W$_2$

T$_9$ Line sowing (30 cm) + Pendimethalin @ 0.500kg ha$^{-1}$ pre-emergence *fb* HW 30 DAS M$_2$W$_3$

T$_{10}$ Line sowing (30 cm) + Metribuzin @ 0.400kg ha$^{-1}$ pre-emergence *fb* HW 30 DAS M$_2$W$_4$

T$_{11}$ Line sowing (30 cm) + Hand weeding at 30 and 45 DAS M$_2$W$_5$

T$_{12}$ Line sowing (30 cm) + Weedy check M$_2$W$_6$

## Results and Discussion

**Plant population:** The plant population no. m$^{-2}$ recorded at 30 DAS and at harvest (Table 1) revealed that the Plant stand of chicory recorded at 30 DAS and at harvest were significantly higher under treatment of broadcasting (M$_1$) method as compared to line-sowing (M$_2$).This might be due to uneven distribution of seeds in broadcasting method than line-sowing. This result is in conformity with the finding of Mehta *et al*. (1995) [3]. Plant stand of chicory recorded at 30 DAS and at harvest were significantly higher under treatment of Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS (W$_3$).

**No. of Leaves plant$^{-1}$:** At harvest, there was non-significant differences in no. of leaves plant$^{-1}$ of chicory observed due to different methods of sowing and weed management practices. Numerically higher no. of leaves plant$^{-1}$ was observed under treatment of line-sowing (30 cm) in methods of sowing and Pendimethalin 0.500kg ha$^{-1}$ PE *fb* HW 30 DAS (W$_3$) in different weed management practices.

**Root volume (cm$^3$):** Significantly the higher root volume (111.94 cm$^3$) was measured under treatment of line-sowing (M$_2$) than broadcasting method. The higher bulb diameter may be due to uniform distribution of plant in line-sowing so, plant root occupied good space for development, better root growth, nutrient absorption and better root volume Among weed management practices, Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS (W$_3$) produced significantly higher root volume (123.92 cm$^3$) as compared to rest of the treatments except treatment of Metribuzin @ 0.400 kg ha$^{-1}$ PE *fb* HW 30 DAS (W$_4$). While the lowest root volume was recorded in treatment of weedy check (W$_6$). This result is in conformity with the finding of Mehta *et al*. (1995) [3] and Patel *et al*. (2017) [5].

**Table 1:** Plant population, growth attribute and yield attribute as influenced by methods of sowing and weed management practices in chicory

| Treatment | Plant stand (No. m$^{-2}$) | | No. of Leaves plant$^{-1}$ | Root volume (cm$^3$) |
|---|---|---|---|---|
| **Methods of sowing (M)** | **At 30 DAS** | **At harvest** | **At harvest** | |
| M$_1$: Broadcasting | 55.21 | 54.25 | 27.75 | 95.50 |
| M$_2$: Line sowing | 50.87 | 49.50 | 29.04 | 111.94 |
| S. Em± | 0.81 | 0.76 | 0.57 | 1.63 |
| C.D. at 5% | 2.32 | 2.21 | NS | 4.70 |
| **Weed Management Practices (W)** | | | | |
| W$_1$: Pendimethalin @ 0.500 kg ha$^{-1}$ PE | 57.62 | 56.12 | 27.54 | 91.8 |
| W$_2$: Metribuzin @ 0.400 kg ha$^{-1}$ PE | 45.12 | 44.13 | 28.37 | 92.17 |
| W$_3$: Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS | 58.75 | 58.13 | 29.83 | 123.92 |
| W$_4$: Metribuzin @ 0.400 kg ha$^{-1}$ PE *fb* HW 30 DAS | 45.75 | 44.38 | 28.96 | 119.60 |
| W$_5$: Hand weeding at 30 and 45 DAS | 57.37 | 57.12 | 29.28 | 113.50 |
| W$_6$: Weedy check | 53.62 | 51.38 | 26.37 | 81.30 |
| S. Em± | 1.40 | 1.33 | 0.98 | 2.83 |
| C.D. at 5% | 4.03 | 3.89 | NS | 8.15 |
| Interaction M×W | NS | NS | NS | NS |
| C.V. % | 7.47 | 7.26 | 9.80 | 7.72 |

**Fresh root yield (t ha$^{-1}$):** Significantly higher fresh root yield of chicory (14.11 t ha$^{-1}$) was observed under treatment of line-sowing ($M_2$) than broadcasting (Table 3). The higher root yield may be due to line-sowing have uniform distribution of plant so, their root have sufficient space which have better root growth, nutrient absorption and better root development. This result is in conformity with the finding of Mehta *et al.* (1995) [3]. Application of Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS ($W_3$) produced significantly higher fresh root yield of chicory (18.59 t ha$^{-1}$), which was at par with treatment of twice HW at 30 and 45 DAS ($W_5$).While the lowest fresh root yield was recorded in treatment of weedy check. Rathod *et al.* (2010) [7] reported increased $NO_3$-N content in soil by pre-emergence application of dinitroaniline herbicides including Pendimethalin @ 0.500 kg ha$^{-1}$ in sandy loam soil under mustard crop in *rabi* season. Therefore probably in this study higher fresh yield of chicory could be due to increasing available nutrients in soil which had beneficial effect on chicory yield. Treatment combination $M_2W_3$ (Table 3) was recorded significantly higher fresh root yield (20.93 t ha$^{-1}$) as compared to rest of the treatment combination but, it was at par with treatment combination of $M_2W_5$ (19.14 t ha$^{-1}$). This result is in conformity with the finding of Mehta *et al.* (1995) [3].

**Dry root yield (t ha$^{-1}$):** Significantly the higher dry root yield of chicory (5.57 t ha$^{-1}$) was observed under treatment of line-sowing ($M_2$) than broadcasting ($M_1$). Application of Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS ($W_3$) produced significantly higher the dry root yield of chicory (7.32 t ha$^{-1}$), which was at par with treatment of twice HW at 30 and 45 DAS ($W_5$). While the lowest fresh root yield was recorded in treatment of weedy check (Table 3). Treatment combination $M_2W_3$(Table 4) recorded significantly higher dry root yield (8.64 t ha$^{-1}$) as compared to rest of the treatment combination but, it was at par with treatment combination of $M_2W_5$ (8.11 t ha$^{-1}$).

**Weed index (%):** Data presented in the Table 2 showed that effect of weed management practices on the weed index. Among all the weed management practices, weedy check ($W_6$) showed the highest weed index 69.13 per cent, while the lowest weed index (5.05 %) was recorded in twice HW carried out at 30 and 45 DAS ($W_5$), respectively. These results are in conformity with the finding of Panara *et al.* (2015) [4] and Patel *et al.* (2017) [5].

$$WI\ (\%) = X\text{-}Y/X \times 100$$

Where, X= Maximum yield from the treatment,
Y= Yield from the treated plot

**Table 2:** Fresh root yield, dry root yield and Weed index as influenced by methods of sowing and weed management practices in chicory

| Treatment | Fresh root yield (t ha$^{-1}$) | Dry root yield (t ha$^{-1}$) | Weed index (%) |
|---|---|---|---|
| **Methods of sowing (M)** | | | |
| $M_1$: Broadcasting | 11.19 | 4.12 | - |
| $M_2$: Line sowing | 14.11 | 5.57 | - |
| S. Em± | 0.34 | 0.09 | |
| C.D. at 5% | 1.00 | 0.26 | |
| **Weed Management Practices (W)** | | | |
| $W_1$: Pendimethalin @ 0.500 kg ha$^{-1}$ PE | 11.58 | 4.13 | 43.58 |
| $W_2$: Metribuzin @ 0.400 kg ha$^{-1}$ PE | 7.25 | 2.78 | 62.02 |
| $W_3$: Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS | 18.59 | 7.32 | - |
| $W_4$: Metribuzin @ 0.400 kg ha$^{-1}$ PE *fb* HW 30 DAS | 14.86 | 5.63 | 23.09 |
| $W_5$: Hand weeding at 30 and 45 DAS | 17.40 | 6.95 | 05.05 |
| $W_6$: Weedy check | 6.23 | 2.26 | 69.13 |
| S. Em± | 0.60 | 0.15 | |
| C.D. at 5% | 1.74 | 0.44 | |
| **Interaction M×W** | | | |
| S. Em± | 0.86 | 0.22 | |
| C.D. at 5 % | 2.46 | 0.63 | |
| C.V.% | 13.51 | 9.02 | |

**Table 3:** Fresh root yield of chicory as influenced by interaction of methods of sowing and weed management practices at harvest

| Treatments | Fresh root yield (t ha$^{-1}$) | |
|---|---|---|
| | Methods of sowing | |
| **Weed management practices** | **$M_1$** | **$M_2$** |
| $W_1$: Pendimethalin@ 0.500 kg ha$^{-1}$ PE | 9.43 | 13.73 |
| $W_2$: Metribuzin @ 0.400 kg ha$^{-1}$ PE | 7.04 | 7.46 |
| $W_3$: Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS | 16.25 | 20.93 |
| $W_4$: Metribuzin @ 0.400 kg ha$^{-1}$ PE *fb* HW 30 DAS | 12.76 | 16.97 |
| $W_5$: Hand weeding at 30 and 45 DAS | 15.68 | 19.14 |
| $W_6$: weedy check | 6.02 | 6.46 |
| S. Em± | 0.86 | |
| C.D. at 5 % | 2.46 | |
| C.V.% | 13.51 | |

**Table 4:** Dry root yield of chicory as influenced by interaction of methods of sowing and weed management practices at harvest

| Treatments | Dry root yield (t ha$^{-1}$) | |
|---|---|---|
| | Methods of sowing | |
| **Weed management practices** | **$M_1$** | **$M_2$** |
| $W_1$: Pendimethalin@ 0.500 kg ha$^{-1}$ PE | 3.46 | 4.80 |
| $W_2$: Metribuzin @ 0.400 kg ha$^{-1}$ PE | 2.68 | 2.89 |
| $W_3$: Pendimethalin @ 0.500 kg ha$^{-1}$ PE *fb* HW 30 DAS | 5.99 | 8.64 |
| $W_4$: Metribuzin @ 0.400 kg ha$^{-1}$ PE *fb* HW 30 DAS | 4.69 | 6.58 |
| $W_5$: Hand weeding at 30 and 45 DAS | 5.79 | 8.11 |
| $W_6$: weedy check | 2.32 | 2.39 |
| S. Em± | 0.22 | |
| C.D. at 5 % | 0.63 | |
| C.V.% | 9.02 | |

## Conclusion

In the light of above experimental results, it can be concluded that weeds could be managed either by line-sowing of chicory with pre-emergence application of Pendimethalin @ 0.500 kg ha$^{-1}$ *fb* hand weeding at 30 days after sowing or two hand weeding at 30 and 45 days after sowing for obtaining higher root yield and net return.

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