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**Mohitesh Singh**

P.G. Department of Agriculture,  
Khalsa College, Amritsar, Punjab,  
India

**Gurbax Singh Chhina**

P.G. Department of Agriculture,  
Khalsa College, Amritsar, Punjab,  
India

**Ranjot Kaur**

P.G. Department of Agriculture,  
Khalsa College, Amritsar, Punjab,  
India

## Impact of sowing techniques and herbicide combinations on weed flora in wheat (*Triticum aestivum*)

**Mohitesh Singh, Gurbax Singh Chhina and Ranjot Kaur**

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### Abstract

The field experiment entitled “Impact of Sowing Techniques and Herbicide Combinations on Weed Flora in Wheat (*Triticum aestivum*)” was conducted at Students’ Research Farm, Khalsa College, Amritsar during *rabi* season of 2020-21. The field experiment was conducted in split-plot design with three methods of sowing viz. Conventional tillage (M<sub>1</sub>), Super seeder (M<sub>2</sub>) and Happy seeder (M<sub>3</sub>) in main plots while seven weed management practices in sub-plots viz. W<sub>1</sub>(pinoxaden + clodinafop), W<sub>2</sub> (fenoxaprop + metribuzin), W<sub>3</sub> (metsulfuron-methyl + carfentrazone-ethyl + NIS), W<sub>4</sub> (pendimethalin *fb* pinoxaden + metsulfuron-methyl), W<sub>5</sub> (isoproturon + 2,4-D), W<sub>6</sub> (weed free), W<sub>7</sub> (weedy check) replicated thrice. Among the different methods of crop establishment, total reduction in weed density and biomass of weeds was observed in happy seeder sown wheat (M<sub>3</sub>) followed by the super seeder sown wheat (M<sub>2</sub>), however the maximum was found in conventional tillage sown wheat (M<sub>1</sub>). Super seeder sown wheat recorded highest grain yield and straw yield as well. Among the various weed control treatments, W<sub>4</sub> enhanced of growth, yield and benefit cost ratio of wheat which was at par with W<sub>6</sub> (weed free), W<sub>1</sub> and W<sub>2</sub> and significantly better than W<sub>3</sub>, W<sub>5</sub> and W<sub>7</sub> as compared to weedy check, the higher yield attribute character and yield of wheat was produced with herbicidal treatments. The maximum yield (54.29 q ha<sup>-1</sup>) was achieved by first spraying of pre-emergence herbicide pendimethalin *fb* post-emergence application of pinoxaden + metsulfuron-methyl in W<sub>4</sub> treatment.

**Keywords:** Conventional tillage, herbicide, happy seeder, super seeder, weed, wheat

### Introduction

Wheat (*Triticum aestivum* L.) is *rabi* season crop which cover large area in world. In Punjab, the total area under wheat cultivation was 35.30 lakh hectares during 2020-21 with production of 171.8 lakh tonnes and average yield of 48.68 quintals per hectare. Traditional method of wheat establishment involves excessive tillage which is time & energy consuming (Tripathi *et al.* 2002) [8]. The sowing of wheat after harvest of transplanted rice is generally delayed due to intensive tillage operation for seed bed preparation under conventional system. This results in reduced crop duration, equivalent to an extent of 1.0-1.5% yield loss/hectare/day (Gathala *et al.* 2011) [4]. On the other hand, production of the wheat crop is directly impacted by several biotic and abiotic factors. Among these, the most limiting biological constraint is the infestation of weeds. The yield losses of wheat vary between 17-30% annually (Rao and Chauhan, 2015) [5]. Weed problem is one of the major barriers responsible for low productivity of wheat because weed competes with the crop for moisture, nutrients, space, light etc. Wheat is infested by both grass & broad leaf weeds. The prominent weeds noted in wheat field are *Phalaris minor*, *Rumex dentatus*, *Rumex spinosus*, *Chenopodium album*, *Anagallis arvensis*, *Avena fatua*, *Convolvulus arvensis*, *Euphorbia helioscopia* and *Cannabis sativa*. *Phalaris minor* is one of the very serious weed in wheat and sometimes almost 100% crop losses have been reported by Singh and Singh. No-till system in wheat under rice wheat system reduced the *Phalaris minor* (littleseed canarygrass) infestation (Chhokar *et al.* 2007, Singh 2007) [3, 7] due to higher soil strength but favoured the infestation of broad-leaved weeds like *Rumex dentatus* (toothed dock), *Malva parviflora* (little mallow) and *Medicago denticulate* (burclover). That is why the use of herbicides could be the only way to check the weeds and improve the crop yields. Herbicide application increased grain yield as compared to un-weeded and hand weeding

**Corresponding Author:**

**Mohitesh Singh**

P.G. Department of Agriculture,  
Khalsa College, Amritsar, Punjab,  
India

treatments (Amin *et al.* 2008) [1]. Combination of grassy and broad leaf herbicides was better than their separate application for weed control in wheat shift in weed species (Shahzad *et al.* 2016). Pre-mixed broad-spectrum herbicide is cost-effective against complex weed flora. In present study, the different methods of tillage and the efficiency of combination of pre and post-emergence herbicide used in sequence as tank-mix or as pre-mix against weeds on growth and yield of wheat was evaluated.

### Materials and Methods

Field study was carried out during *rabi* seasons for year 2020-2021 at the Khalsa college, Amritsar (Location 31.63°E and 74.87°N, 234 metres above mean sea-level). It was a split plot experiment conducted replicated with thrice, having two factors. First factor comprised of three sowing methods, Conventional tillage (M<sub>1</sub>), Super seeder (M<sub>2</sub>) and Happy seeder (M<sub>3</sub>) whereas, second factor comprised of seven herbicides, viz., (W<sub>1</sub>) Pinoxaden+ Clodinafop-propargyl (70 g ha<sup>-1</sup>), (W<sub>2</sub>) Fenoxaprop+Metribuzin (110 g ha<sup>-1</sup>), (W<sub>3</sub>) Metsulfuron-methyl(4 g ha<sup>-1</sup>) +Carfentrazone-ethyl (25 g ha<sup>-1</sup>) +NIS, (W<sub>4</sub>)

Pendimethalin (900 g ha<sup>-1</sup>) *fb* Pinoxaden+ Metsulfuron-methyl (60g ha<sup>-1</sup>), (W<sub>5</sub>) Isoproturon+2,4-D(500 g ha<sup>-1</sup>), (W<sub>6</sub>) Weed Free and (W<sub>7</sub>) Weedy Check. The wheat variety “Unnat PBW343” was grown and recommended doses of fertilizers were applied. Herbicides were sprayed by knapsack sprayer fitted with flat-fan and flood jet nozzle using a spray volume of 500 L/ha. Weedy check plots remained infested with native population of weeds till harvest. Observation on weed density and dry matter accumulation were recorded from 4 random quadrates of 30cm × 30cm in each plot at 30, 60 and 90 days after herbicide application. Total number of weeds falling within each quadrate were counted and cut at ground level for measuring weed dry weight data. The sample were first dried in sun and after then kept in oven at 65 °C. The dried samples were weighted and expressed in g/m<sup>2</sup>. Data on weeds were subjected to square-roots transformation to normalize their distribution. The Grain yield recorded in kg/plot was finally converted into grain yield kg/ha and then into q/ha. The statistical analysis of data was done using 5% level of significance.

### Results and Discussion

**Table 1:** Effect of sowing methods and weed control practices on weed density (no/m<sup>2</sup>) of narrow leaf weeds and broad leaf weeds

| Treatments                                                               | Weed density (no/m <sup>2</sup> ) (Narrow leaf weeds) |        |        |         |            | Weed density (no/m <sup>2</sup> ) (Broad leaf weeds) |        |        |         |            |
|--------------------------------------------------------------------------|-------------------------------------------------------|--------|--------|---------|------------|------------------------------------------------------|--------|--------|---------|------------|
|                                                                          | 30 DAS                                                | 60 DAS | 90 DAS | 120 DAS | At harvest | 30 DAS                                               | 60 DAS | 90 DAS | 120 DAS | At Harvest |
| <b>Sowing methods</b>                                                    |                                                       |        |        |         |            |                                                      |        |        |         |            |
| Conventional Tillage (M <sub>1</sub> )                                   | 7.86                                                  | 7.47   | 7.22   | 6.99    | 6.69       | 6.18                                                 | 4.18   | 3.93   | 3.63    | 3.33       |
| Super seeder (M <sub>2</sub> )                                           | 7.71                                                  | 7.30   | 7.04   | 6.79    | 6.48       | 5.98                                                 | 3.86   | 3.57   | 3.21    | 2.85       |
| Happy seeder (M <sub>3</sub> )                                           | 7.25                                                  | 6.72   | 6.36   | 6.04    | 5.65       | 6.48                                                 | 4.63   | 4.41   | 4.12    | 3.87       |
| LSD (p=0.05)                                                             | NS                                                    | NS     | NS     | NS      | NS         | NS                                                   | NS     | NS     | NS      | NS         |
| <b>Weed management practices</b>                                         |                                                       |        |        |         |            |                                                      |        |        |         |            |
| Pinoxaden + Clodinafop-propargyl (W <sub>1</sub> )                       | 9.50                                                  | 7.30   | 6.03   | 5.23    | 4.43       | 7.45                                                 | 4.32   | 3.97   | 3.60    | 3.15       |
| Fenoxaprop + Metribuzin (W <sub>2</sub> )                                | 9.55                                                  | 7.37   | 6.12   | 5.34    | 4.55       | 7.46                                                 | 4.40   | 4.06   | 3.70    | 3.26       |
| Metsulfuron-methyl + Carfentrazone-ethyl + NIS (W <sub>3</sub> )         | 9.56                                                  | 8.32   | 7.16   | 6.65    | 6.01       | 7.54                                                 | 4.23   | 3.62   | 3.19    | 2.65       |
| Pendimethalin <i>fb</i> Pinoxaden + Metsulfuron-methyl (W <sub>4</sub> ) | 4.53                                                  | 3.29   | 2.90   | 2.64    | 2.59       | 4.81                                                 | 3.08   | 2.74   | 2.43    | 2.19       |
| Isoproturon + 2,4-D (W <sub>5</sub> )                                    | 9.58                                                  | 11.53  | 11.39  | 11.23   | 10.66      | 7.62                                                 | 4.77   | 4.35   | 3.90    | 3.76       |
| Weed Free (W <sub>6</sub> )                                              | 1(0)                                                  | 1(0)   | 1(0)   | 1(0)    | 1(0)       | 1(0)                                                 | 1(0)   | 1(0)   | 1(0)    | 1(0)       |
| Weedy Check (W <sub>7</sub> )                                            | 9.55                                                  | 13.84  | 16.23  | 16.97   | 17.06      | 7.63                                                 | 7.75   | 8.05   | 7.78    | 7.45       |
| LSD (p=0.05)                                                             | 0.95                                                  | 0.72   | 0.83   | 0.88    | 0.90       | 0.71                                                 | 0.57   | 0.60   | 0.37    | 0.36       |
| Interaction                                                              | NS                                                    | NS     | NS     | NS      | NS         | NS                                                   | NS     | NS     | NS      | NS         |

The original data in parenthesis was subjected to  $\sqrt{x+1}$  transformation

### Weed density of narrow leaf weeds (m<sup>-2</sup>)

Weeds caused substantial yield losses to wheat. The crop-weed competition for nutrients, space, moisture, light etc. The narrow leaf weeds causes very heavy losses to the wheat crop. In the pertaining data, table 1, showed that the weed count was maximum in conventional tillage (7.86) under main plots followed by super seeder (7.71) and minimum in happy seeder (7.25) throughout the crop season. At 60,90, 120DAS and at harvest the minimum weed count was observed in happy seeder, this might be due to the sowing method and minimum soil disturbance due to which the narrow leaf weeds cannot come to upper surface of soil and thereby lowering the narrow weed leaf flora in happy seeder sown wheat. The weed count of super

seeder (65.49) sown wheat recorded 4.04% reduction in weed density when compared with conventional tillage (68.25), however when conventional tillage was compared with happy seeder (58.02) there was 17.63% reduction in weed density of narrow-leaf weeds.

In sub-plots, throughout the crop season weed count was recorded highest in W<sub>7</sub> (weedy check) and minimum in W<sub>4</sub> treatment followed by W<sub>1</sub>, W<sub>2</sub>, W<sub>3</sub> and W<sub>5</sub> treatment. Among chemical weed control treatments, the maximum weed count was observed in W<sub>5</sub> followed by W<sub>3</sub>, W<sub>2</sub> and W<sub>1</sub>, at 60, 90,120 DAS and at harvest. The percentage decrease in weed count of W<sub>1</sub>, W<sub>2</sub>, W<sub>3</sub>, W<sub>4</sub>, W<sub>5</sub> and W<sub>6</sub> when compared with W<sub>7</sub> was 93.46%, 93.07%, 87.83%, 97.59%, 76.74% and 100%.

**Table 2:** Effect of sowing methods and weed control practices on dry matter accumulation (q/ha<sup>-1</sup>) of narrow leaf weeds and broad leaf weeds

| Treatments                                                               | Dry matter accumulation (q ha <sup>-1</sup> )<br>(Narrow leaf weeds) |        |        |         |            | Dry matter accumulation (q ha <sup>-1</sup> )<br>(Broad leaf weeds) |        |        |         |            |
|--------------------------------------------------------------------------|----------------------------------------------------------------------|--------|--------|---------|------------|---------------------------------------------------------------------|--------|--------|---------|------------|
|                                                                          | 30 DAS                                                               | 60 DAS | 90 DAS | 120 DAS | At harvest | 30 DAS                                                              | 60 DAS | 90 DAS | 120 DAS | At harvest |
| <b>Main Plot-Sowing methods</b>                                          |                                                                      |        |        |         |            |                                                                     |        |        |         |            |
| Conventional Tillage (M <sub>1</sub> )                                   | 1.50                                                                 | 1.86   | 2.51   | 3.42    | 2.79       | 1.34                                                                | 1.84   | 2.29   | 2.53    | 2.26       |
| Super seeder (M <sub>2</sub> )                                           | 1.46                                                                 | 1.74   | 2.30   | 3.27    | 2.66       | 1.30                                                                | 1.83   | 2.46   | 2.43    | 2.20       |
| Happy seeder (M <sub>3</sub> )                                           | 1.54                                                                 | 1.62   | 2.05   | 3.11    | 2.51       | 1.39                                                                | 1.86   | 2.54   | 2.61    | 2.32       |
| LSD (p=0.05)                                                             | NS                                                                   | NS     | NS     | NS      | NS         | NS                                                                  | NS     | NS     | NS      | NS         |
| <b>Sub Plot-Weed management practices</b>                                |                                                                      |        |        |         |            |                                                                     |        |        |         |            |
| Pinoxaden + Clodinafop-propargyl (W <sub>1</sub> )                       | 1.70                                                                 | 1.74   | 1.89   | 2.43    | 2.04       | 1.45                                                                | 1.76   | 1.90   | 2.17    | 1.74       |
| Fenoxaprop + Metribuzin (W <sub>2</sub> )                                | 1.71                                                                 | 1.80   | 2.03   | 2.80    | 2.34       | 1.46                                                                | 1.80   | 1.99   | 2.22    | 1.77       |
| Metsulfuron-methyl + Carfentrazone-ethyl + NIS (W <sub>3</sub> )         | 1.68                                                                 | 1.85   | 2.20   | 4.11    | 2.62       | 1.48                                                                | 1.72   | 2.27   | 2.44    | 2.26       |
| Pendimethalin <i>fb</i> Pinoxaden + Metsulfuron-methyl (W <sub>4</sub> ) | 1.01                                                                 | 1.04   | 1.06   | 1.09    | 1.08       | 1.005                                                               | 1.009  | 1.026  | 1.03    | 1.04       |
| Isoproturon + 2,4-D (W <sub>5</sub> )                                    | 1.707                                                                | 1.96   | 3.57   | 5.27    | 4.34       | 1.50                                                                | 2.66   | 3.813  | 4.39    | 3.98       |
| Weed Free (W <sub>6</sub> )                                              | 1(0)                                                                 | 1(0)   | 1(0)   | 1(0)    | 1(0)       | 1(0)                                                                | 1(0)   | 1(0)   | 1(0)    | 1(0)       |
| Weedy Check (W <sub>7</sub> )                                            | 1.704                                                                | 2.79   | 4.29   | 6.18    | 5.14       | 1.52                                                                | 2.97   | 3.95   | 4.42    | 4.06       |
| LSD (p=0.05)                                                             | 0.08                                                                 | 0.21   | 0.38   | 0.28    | 0.30       | 0.04                                                                | 0.25   | 0.37   | 0.43    | 0.25       |
| Interaction                                                              | NS                                                                   | NS     | NS     | NS      | NS         | NS                                                                  | NS     | NS     | NS      | NS         |

The original data in parenthesis was subjected to  $\sqrt{x+1}$  transformation

#### Dry matter accumulation of narrow- leaf weeds (q ha<sup>-1</sup>)

The dry matter accumulation by weed shows that throughout the cropping season much nutrition is acquired by weeds. The losses caused by these weeds leads to the poor crop yield. In happy seeder sown wheat, narrow-leaf weeds accumulated the least dry matter throughout the cropping season and conventional tillage received comparatively highest weed dry weight. The weed dry matter of super seeder (8.34) wheat recorded 7.74% reduction in weed density when compared with conventional tillage (9.04), however when conventional tillage was compared with happy seeder (7.64) there was 15.48% reduction in weed dry matter of narrow-leaf weeds.

W<sub>4</sub> treatment had the lowest weed dry weight of narrow-leaf weeds, followed by W<sub>1</sub>, W<sub>2</sub>, W<sub>3</sub>, W<sub>5</sub> and treatment throughout the crop season. The percentage decrease in weed dry weight of W<sub>1</sub>, W<sub>2</sub>, W<sub>3</sub>, W<sub>4</sub>, W<sub>5</sub> and W<sub>6</sub> when compared with W<sub>7</sub> was 87.44%, 82.35%, 76.57%, 99.30%, 29.42% and 100%. It was observed that the interaction was not significant.

#### Dry matter accumulation of broad leaf weeds (q ha<sup>-1</sup>)

Super-seeder sown wheat had the lowest dry matter buildup of broad-leaf weeds, and highest in happy seeder sown wheat. But the differences were not reached to significant level. The weed dry matter of conventional tillage (5.65) recorded 7.37% reduction in weed density when compared with happy seeder (6.10), however when conventional tillage was compared with super seeder (5.19) there was 14.51% reduction in weed density of broad-leaf weeds.

W<sub>4</sub> had the lowest weed dry matter accumulation and W<sub>7</sub> had the highest dry matter accumulation of broad-leaf weeds across the various weed management strategies. W<sub>1</sub> and W<sub>2</sub> were shown to be significantly differ from W<sub>3</sub> and W<sub>5</sub>. Further difference between W<sub>3</sub> and W<sub>5</sub> was significant. The descending order of weed dry matter was 15.83, 15.18, 4.18, 2.19, 2.08 and 0.09 in W<sub>7</sub>, W<sub>5</sub>, W<sub>3</sub>, W<sub>2</sub>, W<sub>1</sub> and W<sub>4</sub> respectively. The percentage decrease in dry matter of W<sub>1</sub>, W<sub>2</sub>, W<sub>3</sub>, W<sub>4</sub>, W<sub>5</sub> and W<sub>6</sub> when compared with W<sub>7</sub> was 86.86%, 86.16%, 73.59%, 99.43%, 4.10% and 100%.

**Table 3:** Effect of sowing methods and weed control treatments on grain yield, straw yield and harvest index of wheat

| Treatments                                                               | Grain yield (q/ha) | Straw yield (q/ha) | Harvest index (%) |
|--------------------------------------------------------------------------|--------------------|--------------------|-------------------|
| <b>Main Plot-Sowing methods</b>                                          |                    |                    |                   |
| Conventional Tillage (M <sub>1</sub> )                                   | 46.5               | 68.26              | 40.52             |
| Super seeder (M <sub>2</sub> )                                           | 47.78              | 71.66              | 40.01             |
| Happy seeder (M <sub>3</sub> )                                           | 42.85              | 62.44              | 40.70             |
| CD (p=0.05)                                                              | 3.89               | 5.28               |                   |
| <b>Sub Plot-Weed management practices</b>                                |                    |                    |                   |
| Pinoxaden + Clodinafop-propargyl (W <sub>1</sub> )                       | 50.95              | 74.49              | 40.77             |
| Fenoxaprop + Metribuzin (W <sub>2</sub> )                                | 50.39              | 73.70              | 40.90             |
| Metsulfuron-methyl + Carfentrazone-ethyl + NIS (W <sub>3</sub> )         | 46.5               | 66.58              | 41.36             |
| Pendimethalin <i>fb</i> Pinoxaden + Metsulfuron-methyl (W <sub>4</sub> ) | 54.29              | 81.10              | 40.24             |
| Isoproturon + 2,4-D (W <sub>5</sub> )                                    | 32.2               | 49.54              | 39.39             |
| Weed Free (W <sub>6</sub> )                                              | 55.15              | 83.07              | 40.08             |
| Weedy Check (W <sub>7</sub> )                                            | 27.76              | 43.17              | 39.13             |
| CD (p=0.05)                                                              | 4.58               | 7.33               |                   |
| Main*Sub                                                                 | NS                 | NS                 |                   |

#### Grain yield (q ha<sup>-1</sup>)

The cumulative influence of experimental variables was reflected in ultimate crop production, making it a crucial

criterion for determining the efficacy of different treatments in a given context. The effectiveness of various components is primarily measured by the amount of additional yield they

produce. The results in above table showed that among the various ways of sowing wheat, super seeder (47.78) sown wheat produced the highest grain yield, which was much higher than conventional tillage (46.5) which was at par with happy seeder (42.85), however the super seeder (47.78) and happy seeder (42.85) sown wheat differed significantly. Maximum grain yield was observed in super seeder (47.78) which was 2.75% higher than the conventional tillage (46.5) and 11.50% higher than the happy seeder (42.85) sown wheat.

In sub plot,  $W_6$  (weed free) treatment had the highest grain yield and it was significantly at par with  $W_4$  (pendimethalin fb pinoxaden + metsulfuron-methyl),  $W_1$  (pinoxaden + clodinafop) and  $W_2$  (fenoxaprop + metribuzin) significantly higher than  $W_3$ ,  $W_5$  and  $W_7$  treatments. However the treatments  $W_5$  (isoproturon + 2,4-D) and  $W_7$  (weedy check) were significantly at par with each other. The treatment  $W_2$  and  $W_3$  were also significantly at par with each other. The  $W_7$  treatment, on the other hand, produced the lowest grain yield. Due to fewer tillers per metre row length and fewer grains per ear, yield was reduced by 44.71 percent in the control compared to the weed-free treatment. The percentage increase in grain yield of  $W_1$ ,  $W_2$ ,  $W_3$ ,  $W_4$ ,  $W_5$  and  $W_6$  when compared with  $W_7$  was 45.51%, 44.90%, 40.30%, 48.86%, 13.78% and 49.66%.

### Straw yield ( $q\ ha^{-1}$ )

Straw yield is a significant measure of biological yield for determining its productivity index and determining the photosynthetic mass's ultimate efficacy. Wheat straw has a significant impact on the efficacy of several treatments examined in a study. The results showed that among the various methods of sowing wheat, super seeder sown wheat produced the highest straw yield, which was much higher than conventional tillage seeded wheat, but happy seeder sown wheat produced the lowest grain yield. Because there were more tillers per metre row length and more grains per ear in super seeder sown wheat, the straw production was 14.76 percent higher than in happy seeder (62.44) seeded wheat. The percentage increase in straw yield in super seeder (71.66) when compared with conventional tillage (68.26) was 4.98% and with happy seeder was 14.76%.

Among the different weed control practices,  $W_6$  (weed free) treatment had the highest straw yield and it was significantly at par with  $W_4$  (pendimethalin fb pinoxaden + metsulfuron-methyl),  $W_1$  (pinoxaden + clodinafop) and  $W_2$  (fenoxaprop + metribuzin), which were significantly higher than  $W_3$ ,  $W_5$  and  $W_7$  treatments. The treatment  $W_3$  and  $W_2$  were also significantly at par with each other. The  $W_7$  treatment, on the other hand, produced the lowest straw yield. The number of tillers per metre row length and the number of grains per ear were both reduced in the control as compared to weed-free treatment, resulting in 48.03 percent loss in straw yield. The percentage increase in straw yield of  $W_1$ ,  $W_2$ ,  $W_3$ ,  $W_4$ ,  $W_5$  and  $W_6$  when compared with  $W_7$  was 42.04%, 41.42%, 35.16%, 46.76%, 13.72% and 48.03%.

### Harvest index

The harvest index is a crucial metric that displays how photosynthates are divided up economically. The higher the harvest index, the more efficient the plant is at producing economic yield. The highest harvest index was observed in happy seeder sown wheat, while the lowest harvest index was reported in super seeder sown wheat. The highest harvest index was observed in the  $W_3$  (metsulfuron + carfentrazone + NIS) treatment, while the lowest harvest index was reported in the  $W_7$  (weedy check) treatment, which could be attributable to more

weed flora in weedy check treatment.

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