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# Assessment of yield and nutrient losses due to weeds in maize based cropping systems

**Suresha, Ashish Kumar, S.S. Rana, S.C. Negi and Suresh Kumar**
Department of Agronomy, Forages and Grassland Management
COA, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062
ashish2587@hotmail.com

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## Abstract

The present study was carried out in a continuing experiment at the Bhadiarkhar farm of the Department of Agronomy, CSKHPKV, Palampur during 2012-13 and 2013-14. The soil was silty clay loam in texture, high in OC (0.99%), medium in available N (305.1 kg/ha) and high in available P (78.5 kg/ha) and K (117.4 kg/ha). There were eight cropping systems [$C_1$- Maize – Wheat, $C_2$ - Maize (Green cob) + Frenchbean (Pol) – Pea – Summer squash; $C_3$ - Maize + Soybean – Garlic; $C_4$ - Maize (Green cob) – Broccoli – Potato; $C_5$ - Maize + Asparagus bean – Radish – Onion; $C_6$ - Maize (Green cob) + Urd bean – Cauliflower – Frenchbean; $C_7$ - Maize (Green cob) + Ricebean – Cauliflower – Buckwheat and $C_8$ - Maize (Green cob) + Asparagus bean – Broccoli – Radish] being tested in RBD with four replications. In each experimental plot three weed management situations ($S_1$ - normal weed control, $S_2$ - no weed control/weedy check and $S_3$ - supplement weed control) were maintained and observations on crops and weeds were recorded. There were 28 weed species which invaded different maize based cropping systems. During *kharif*, $S_2$ situation encompasses 6-7 weeds during 2013, $S_1$ 6-7 during 2012 and 8-9 during 2013, whereas in the $S_3$ only 3-4 species were present during both years. *Commelina benghalensis* (56% and 41% during 2012 and 2013, respectively) and *Ageratum* (21% and 33%) were the predominant weeds. In rabi, *Coronopus didymus*, *Phalaris minor* and *Spergula arvensis* (54, 22 and 14%, respectively during 2012-13 and 31, 7 and 28% during 2013-14) were the main weeds. Irrespective of the situation, under the new cropping systems 5-10 weed species were similar whereas, 0-5 species were new as compared to the prevalent maize – wheat cropping system during the *rabi* season. Maize + asparagus bean – radish – onion gave 245 and 503.9% higher maize grain equivalent yield over maize - wheat during 2012-13 and 2013-14, respectively. N depletion by weeds ranged from 608 to 695 and 309.1 to 461.2, P from 121.6 to 177.1 and 71.1 to 99.6 and K from 202.7 to 432.5 and 118.4 to 166.0 kg/ha/annum, during 2012-13 and 2013-14, respectively. Weeds inflicted huge yield losses ranging from 15.7% in $C_6$ to 35.6% in $C_1$.

**Key words:** Maize based cropping systems, Weeds, Shannon Weir Index, Nutrient losses, Yield losses

Maize- wheat is the most predominant cropping system in mid hills of Himachal Pradesh. There were significant research achievements in the past, but the productivity of maize–wheat system is far below the potential yield of the crops. Recommendations on improved crop production technologies have been made (HPKV, 2007a, b &c), but the farmers have not succeeded in taking full advantage of these scientific interventions (Singh *et al*, 1998). Despite enormous growth of maize-wheat system, reports of stagnation in the productivity, with possible decline in production in future, have raised doubts on its sustainability. Earlier studies have indicated superiority of alternative vegetable based cropping systems over the traditional cropping systems (Rana *et al*. 2010 & 2011, Sharma *et al*. 2007 & 2009). Such declining trend in productivity associated with decline in factor productivity may be attributed largely to emergence of multi-nutrient deficiencies and building up of soil pathogens and weed flora besides increasing soil health problems.

Weeds are the most limiting factors in crop production (Buhler, 1992). If left uncontrolled, the weeds in many fields are capable of reducing yields by more than 80% (Karlen *et al*. 2002). With prolonged cultivation of maize-wheat system, many weed species have increased to a greater extent. Nevertheless with diversification of the system, the behaviour of weeds in maize as a function of preceding *rabi* and summer season crop may change. The crop(s), cropping systems and varying management practices like organic inputs, tillage conditions, water control,

crop rotation, fertilizer application and herbicide use have been reported to affect significantly weed communities in a range of agroecosystems (Lesson et al. 2000; Liebman and Davis, 2000). In Indian region, except few (Srivastava and Singh, 2005) scanty information is available on comparative evaluation of weed diversity in different cropping systems. Studying the weed diversity/ dynamics is helpful to understand the dominance or absence of a particular weed species in a cropping system. Estimating nutrient and yield losses due to weeds is equally important for having better strategy for their management.

## Materials and Methods

A study was carried out in a continuing experiment, at the Bhadiarkhar farm of the Krishi Vishvavidyalaya. Eight cropping systems [$C_1$- Maize – Wheat (M-W), $C_2$ - Maize (Green cob) + Frenchbean (Pole) – Pea – Summer squash (Mgc+Fb-P-Ss); $C_3$ - Maize + Soybean – Garlic (M+S-G); $C_4$ - Maize (Green cob) – Broccoli – Potato (MGc-Br-Po); $C_5$ - Maize + Asparagus bean – Radish – Onion (M+Ab-Ra-O); $C_6$ - Maize (Green cob) + Mash – Cauliflower – Frenchbean (Mgc+Ub-C-Fb); $C_7$ - Maize (Green cob) + Ricebean – Cauliflower – Buckwheat (Mgc+Rb-C-Bw) and $C_8$ - Maize (Green cob) + Asparagus bean – Broccoli – Radish (Mgc+Ab-Br-Ra)] were evaluated in a randomized block design with four replications. The soil of the experiment site was silty-clay loam with pH 5.38, OC 0.99%, Available N 305.1, P 78.5 and K 117.4 kg/ha. The crops were raised in accordance with the recommended package of practices for the region.

Yields were harvested from net plot. For comparison between cropping sequences, the yields of crops were converted into maize-grain equivalent yield on price basis. Relative productivity efficiency (RPE) and relative energy output (REO) were determined as below:

RPE (%) = (Total productivity of diversified cropping system - total productivity of existing cropping system)/Total productivity of existing cropping system x 100

REO (%) = Total energy output of the main product under the diversified cropping system/Total energy output of the main products under the existing cropping system x 100

For weed studies three situations were established *i.e* $S_1$ Usual weed control practice (*kharif* as well as *rabi*) using herbicides or manual weed control, $S_2$ No weed control/weedy without herbicide spray or hand weeding (*kharif* as well as *rabi*) and $S_3$ Additional weed control usually handweeding after herbicide spray or manual control (*kharif* as well as *rabi*). These situations were established in each plot and data on weed count and dry weight were recorded. Species-wise weed count was taken at monthly interval from 40 cm x 40 cm quadrate/area in each situation at two sites. The weed count so obtained was converted into No./square metre by multiplying the average count of the weed with factor 6.25. The samples for weed dry weight at monthly interval were taken by placing 25 cm x 25 cm quadrate at random at two sites in each situation. These samples were oven dried at a temperature of 70 $^oC$ till constant weight. The dry matter thus recorded was multiplied by the factor 16.0 to obtain weed dry weight/square metre. The uptake of N, P and K was calculated by multiplying nutrient content with corresponding dry weight.

## Results and Discussion

**Surveillance and distribution of weed species**

There were 28 weed species found growing in association with different maize based cropping systems during a period of two years. This clearly indicated the greater diversity of weed flora that invaded crops and cropping systems in the present investigation. The proportion of different *kharif* and *rabi* weeds at the maximum population stage which was observed in August and January, respectively under undisturbed situation ($S_2$) had been shown in Fig 1. It was clearly indicated that during *kharif, Commelina* was the most dominant weed during both the seasons with infestation to the tune of 56 and 41% during 2012 and 2013, respectively. *Ageratum* sp was next in dominance with invasion percentage of 21 and 33 during 2012 and 2013, respectively. *Cyperus* sp constituted 12% of the total weed flora during 2012 and 6% during 2013. The magnitude of *Bidens pilosa* observed during the course of investigation was to the tune of 4% during both the years. *Aeschynome indica* (5%) during 2012 and *Echinochloa* sp (8%) and *Gallinsoga parviflora* (3%) during 2013 were the other important weeds. The remaining weeds as a whole constituted 2 and 5% of the total weed flora during *kharif* 2012 and 2013, respectively. In rabi, *Coronopus*, *Phalaris* and *Spergula* were the main weeds constituting 54, 22 and 14%, of the total weed flora during 2012-13 and 31, 7 and 28%, respectively during 2013-14. It is clearly indicated that the population of *Coronopus* and *Phalaris* while decreased, that of *Spergula* increased by two fold during the second year as compared to the first year. The proportion of *Avena*, *Anagallis* and *Vicia* was also found higher during the second year. *Trifolium* sp

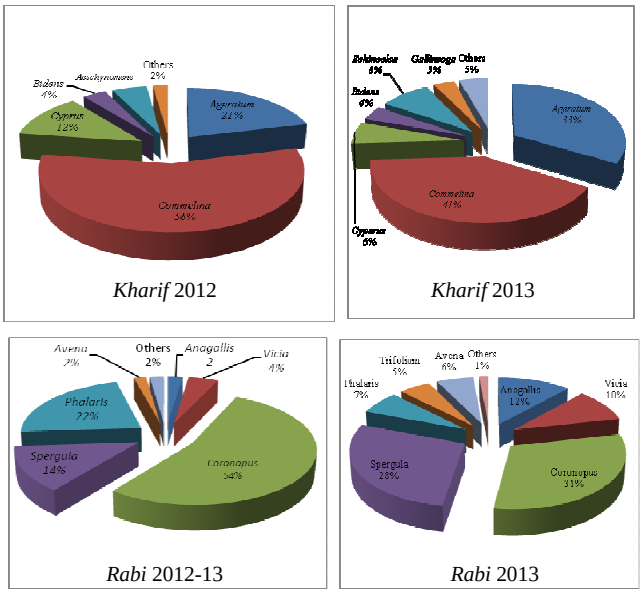


**Fig 1:** Proportion of weeds under undisturbed situation at maximum population during *kharif* (August) and *rabi* (January)

constituted 5% of the total weed flora only during 2013-14. The present investigation clearly revealed that the weeds are dynamic in nature and are greatly influenced by crops and cropping systems, season and management practices being carried out during the crop growth. The other weeds found associated with different crops as a whole constituted 2 and 1% of the total weed flora during 2012-13 and 2013-14, respectively.

**Weed diversity: Shannon Weir Index**

During *kharif* $S_1$ had larger number of weeds than $S_2$ whereas $S_3$ situation has fewer numbers of weeds (Table 1). $S_2$ situation encompasses 6-7 weeds during 2013, $S_1$ 6-7 during 2012 and 8-9 during 2013, whereas in the $S_3$ only 3-4 species were present during both years. $S_2$ is a situation where weeds were allowed to grow uninterrupted and owing to competition or the other aspects of interference the weaker competitors might have been eliminated. When the weed competition is reduced by standard means in the $S_1$, second flush of weeds as in $S_2$ emerged along with some additional weeds. Under such circumstances *Gallinsoga parviflora*, *Echinochloa crusgalli*, *Cynodon dactylon* and *Polygonum* sp. were the important weeds. When the weeds were controlled by use of additional handweeding/hoeing in $S_3$, the weeds appeared were *Ageratum conyzoides*, *Bidens pilosa*, *Ageratum houstonianum*, *Polygonum* sp, *Echinochloa crusgalli*, *Cyperus* sp. This indicated that these weeds

**Table 1.** Cropping systems influence on Shannon Weir Index in *kharif* and *rabi* season weeds under different situations

| Cropping system | *Kharif* | | | | | | | | | | | | *Rabi* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Species common as $C_1$* | | | | | *New species those absent in $C_1$* | | | *Species common as $C_1$* | | | *New species those absent in $C_1$* | | | | | |
| | 2012 | | 2013 | | | 2012 | | | 2013 | | | 2012-13 | | | 2013-14 | | |
| | $S_1$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_3$ | $S_1$ | $S_2$ | $S_3$ | $S_1$ | $S_3$ | $S_1$ | $S_3$ | $S_1$ | $S_3$ | $S_1$ | $S_3$ |
| M-W | 7 | 4 | 9 | 7 | 4 | | | | | | 13 | 12 | 11 | 11 | | | | |
| Mgc + Fb – P – Ss | 7 | 4 | 9 | 7 | 4 | 2 | 0 | 0 | 0 | 0 | 10 | 10 | 7 | 8 | 4 | 2 | 1 | 0 |
| M+S – G | 7 | 3 | 9 | 6 | 4 | 2 | 0 | 0 | 0 | 0 | 9 | 10 | 8 | 9 | 1 | 1 | 0 | 0 |
| Mgc – Br – Po | 7 | 4 | 8 | 7 | 4 | 2 | 0 | 0 | 0 | 0 | 9 | 10 | 7 | 8 | 5 | 2 | 1 | 0 |
| M + Ab – Ra – O | 6 | 4 | 9 | 7 | 4 | 1 | 0 | 0 | 0 | 0 | 8 | 9 | 9 | 9 | 3 | 2 | 1 | 0 |
| Mgc + Ub – C – Fb | 7 | 4 | 9 | 7 | 4 | 0 | 0 | 0 | 0 | 0 | 9 | 10 | 8 | 8 | 5 | 1 | 1 | 0 |
| Mgc + Rb – C – Bw | 7 | 4 | 8 | 7 | 4 | 2 | 0 | 0 | 0 | 0 | 8 | 10 | 6 | 8 | 4 | 1 | 0 | 0 |
| Mgc + Ab – Br – Ra | 7 | 4 | 9 | 6 | 4 | 1 | 0 | 0 | 0 | 0 | 5 | 11 | 8 | 9 | 5 | 1 | 0 | 0 |

were the robust robbers. In spite of repeated means of control, they were not eradicated. Therefore, management strategies should be geared up towards integrated means to keep them under check.

Weed flora during *rabi* was richer than that during *kharif*. Some of the weeds like *Ageratum houstonianum*, *Ageratum conyzoides*, *Polygonum* sp and *Gallinsoga parviflora* those invaded the experimental field during *kharif* were also present during *rabi*. There were contrasting differences between the situations. The weeds such as *Bidens pilosa*, *Gallinsoga parviflora*, *Stellaria media*, *Alopecurus myosuroides*, *Lolium temulentum*, *Ageratum* sp, *Polygonum* sp, *Avena ludoviciana*, *Cynodon dactylon* etc which appeared in the $S_1$ situation (standard weed control practice) were completely eliminated when additional control effort was tried in $S_3$. However, when additional weed control measure was adopted in the $S_3$, species like *Rumex* sp, *Poa annua*, *Polygonum plebegium*, *Trifolium repens*, *Polypogon monspelensis* invaded the fields and a range of crops. Irrespective of the situation, under the new cropping systems 5-10 weed species were similar whereas, 0-5 species were new as compared to the prevalent maize – wheat cropping system during the *rabi* season.

**Maize grain equivalent yield**

It was evident from Table 2 that there was sufficient scope to replace maize-wheat cropping system with other cropping systems without any decline in economic yield. All cropping sequences were significantly superior to the traditional maize – wheat cropping sequence in influencing maize grain equivalent yield. Maize + asparagus bean – radish –onion gave 245 and 503.9% higher maize grain equivalent yield over the traditional maize - wheat cropping sequence during 2012-13 and 2013-14, respectively. The higher yield under the system was owed to higher tonnage of vegetables such as radish and onion. Owing to higher yield, maize + asparagus bean – radish –onion had highest relative productivity efficiency and was followed by $C_8$, $C_4$, $C_6$ and $C_3$ during 2012-13 and $C_2$, $C_4$, $C_7$ and $C_8$ during 2013-14.

Total energy output of the main product was highest under 'maize-wheat' cropping system (28.9 and 21.5 x $10^6$ kcal/ha/annum during 2012-13 and 2013-14, respectively). Total energy output due to the new cropping systems was significantly lower than 'maize – wheat'. 'Maize + Asparagus beans - radish – onion, the better cropping sequences in terms of maize grain equivalent had only 55 and 92.6% of the total energy output under the conventional 'maize-wheat' cropping system during 2012-13 and 2013-14, respectively. However, this cropping system was superior to other cropping systems except maize + soybean – garlic during 2012-13. As indicated by relative energy output, $C_6$-$C_8$ and $C_2$ produced only 19-37% of the total energy output of the 'maize - wheat' cropping system. This indicated that complete diversification of 'maize – wheat' cropping system is neither possible nor advisable. Only 15-20% of the net sown irrigated area may be diversified by small and marginal farmers taking into account the comparative advantage to meet out their cash requirement. These results are in conformity with earlier findings (Rana *et al* 2011).

**Nutrients losses by weeds**

Marked influence of different cropping systems was observed on the NPK depletion by weeds during *kharif* in the first year and during *rabi* in the second year of study under the $S_2$ situation (Table 3). The total yearly NPK uptake was significant due to cropping system in both the years. The nutrient losses due to weeds were huge under the cropping systems. Since nutrient depletion/removal/ uptake is a function of dry weight and content, it followed the trend of dry weight influenced by content. Nitrogen depletion by weeds ranged from 608 – 695 and 309.1 – 461.2 kg/ha/annum during 2012-13 and 2013-14, respectively. Phosphorus depletion was in the range of 121.6 – 177.1 and 71.1 – 99.6 kg/ha/annum during 2012-13 and 2013-14, respectively. Potassium depletion varied from 202.7 – 432.5 and 118.4 – 166.0 kg/ha/annum during 2012-13 and 2013-14, respectively.

**Yield losses by weeds**

Losses in yield due to weeds were estimated based on yield as realized under $S_3$ situation and that estimated under the $S_2$ situation. Weeds inflicted huge losses in yield (Table 4) ranging from 12.8 ($C_3$) to 41.4% ($C_5$) during 2012-13 and from 12.6 ($C_7$) to 39.4% ($C_2$) during 2013-14 based on maize grain equivalent yield. Mean maize grain equivalent yield loss varied from 15.7% in $C_6$ cropping system to 35.6% in the $C_1$ cropping system. Minimum yield loss of 6.7% was in case of maize green cob under the $C_6$ cropping system during 2012-13 and maximum yield loss of 76.8% was of asparagus bean under the $C_5$ cropping system.

The present investigation conclusively inferred that the weeds are dynamic in nature and are greatly influenced by cropping system, season and management practices carried out during the crop growth. They inflict huge nutrient and yield losses suggesting to adopt strong management strategies.

Table 2. Yield (kg/ha) and energy output ($10^6$ K cal/ha/annum) of main product under different crop sequences

| Crop sequence | | Yield main product (kg/ha/annum) | | | | | RPE (%) | Energy out-put | REO (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | *Kharif* | *Intercrop* | Rabi (I) | Rabi (II) | MGEY* | | | |
| | | | | **2012-13** | | | | | |
| $C_1$ | M-W | 2273 | | 6014 | | 9339 | - | 28.9 | - |
| $C_2$ | Mgc + Fb – P - Ss | 3598 | 185 | 3575 | 4967 | 16085 | 72.2 | 6.2 | 21.5 |
| $C_3$ | M+S - G | 2367 | 284 | 4442 | | 16404 | 75.7 | 16.1 | 55.7 |
| $C_4$ | Mgc – Br - Po | 3428 | | 5663 | 8636 | 23390 | 150.5 | 10.7 | 37.0 |
| $C_5$ | M + Ab – Ra - O | 2367 | 152 | 18939 | 10606 | 32216 | 245.0 | 15.9 | 55.0 |
| $C_6$ | Mgc + Ub – C - Fb | 3589 | 133 | 8902 | 2221 | 17396 | 86.3 | 5.6 | 19.4 |
| $C_7$ | Mgc + Rb – C - Bw | 3703 | 161 | 9091 | 1894 | 14977 | 60.4 | 5.5 | 19.0 |
| $C_8$ | Mgc + Ab – Br - Ra | 3485 | 133 | 6553 | 8902 | 27538 | 194.9 | 6.0 | 20.8 |
| | LSD (P=0.05) | | | | | 2984 | | 1.9 | |
| | | | | **2013-14** | | | | | |
| $C_1$ | M-W | 2462 | | 3681 | | 6879 | - | 21.5 | - |
| $C_2$ | Mgc + Fb – P - Ss | 4782 | 284 | 947 | 21412 | 32939 | 378.8 | 7.9 | 36.7 |
| $C_3$ | M+S - G | 2462 | 142 | 2376 | | 9974 | 45.0 | 12.8 | 59.5 |
| $C_4$ | Mgc – Br - Po | 4877 | | 4640 | 12045 | 28612 | 315.9 | 13.9 | 64.7 |
| $C_5$ | M + Ab – Ra - O | 2462 | 151 | 19081 | 19697 | 41544 | 503.9 | 19.9 | 92.6 |
| $C_6$ | Mgc + Ub – C - Fb | 4877 | 134 | 4735 | 2221 | 15491 | 125.2 | 5.4 | 25.1 |
| $C_7$ | Mgc + Rb – C - Bw | 4830 | 160 | 4735 | 5066 | 20998 | 205.2 | 5.6 | 26.0 |
| $C_8$ | Mgc + Ab – Br - Ra | 4924 | 130 | 4735 | 1515 | 16477 | 139.5 | 5.0 | 23.3 |
| | LSD (P=0.05) | | | | | 2101 | | 0.9 | |

**MGEY, maize grain equivalent yield*; RPE, relative productivity efficiency; REO, relative energy output

**Table 3.** Cropping systems' influence on NPK losses by weeds

| Cropping system | N (kg/ha) | | P (kg/ha) | | K (kg/ha) | |
|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| | | | **Kharif** | | | |
| M-W | 256.9 | 294.4 | 51.4 | 67.9 | 85.6 | 113.2 |
| Mgc + Fb – P – Ss | 245.9 | 272.8 | 49.2 | 63.8 | 82.0 | 106.3 |
| M+S – G | 322.5 | 307.7 | 64.5 | 68.9 | 107.5 | 114.8 |
| Mgc – Br – Po | 258.5 | 315.2 | 51.7 | 69.4 | 86.2 | 115.6 |
| M + Ab – Ra – O | 324.6 | 296.2 | 64.9 | 65.9 | 108.2 | 109.8 |
| Mgc + Ub – C – Fb | 333.0 | 326.4 | 66.6 | 70.3 | 111.0 | 117.2 |
| Mgc + Rb – C – Bw | 313.4 | 310.5 | 62.7 | 70.1 | 104.5 | 116.8 |
| Mgc + Ab – Br – Ra | 309.1 | 307.4 | 103.0 | 68.4 | 309.1 | 114.1 |
| LSD (P=0.05) | 36.4 | NS | 7.2 | NS | 12.1 | NS |
| | | | **Rabi** | | | |
| M-W | 365.6 | 149.8 | 73.1 | 30.0 | 121.9 | 49.9 |
| Mgc + Fb – P – Ss | 362.1 | 36.3 | 72.4 | 7.3 | 120.7 | 12.1 |
| M+S – G | 359.8 | 153.5 | 72.0 | 30.7 | 119.9 | 51.2 |
| Mgc – Br – Po | 353.9 | 36.3 | 70.8 | 7.3 | 118.0 | 12.1 |
| M + Ab – Ra – O | 361.9 | 101.3 | 72.4 | 20.3 | 120.6 | 33.8 |
| Mgc + Ub – C – Fb | 360.7 | 40.3 | 72.1 | 8.1 | 120.2 | 13.4 |
| Mgc + Rb – C – Bw | 382.0 | 33.0 | 76.4 | 6.6 | 127.3 | 11.0 |
| Mgc + Ab – Br – Ra | 370.3 | 36.8 | 74.1 | 7.4 | 123.4 | 12.3 |
| LSD (P=0.05) | NS | 18.3 | NS | 3.7 | NS | 6.1 |
| | | | **Total** | | | |
| M-W | 622.5 | 444.2 | 124.5 | 97.9 | 207.5 | 163.1 |
| Mgc + Fb – P – Ss | 608.0 | 309.1 | 121.6 | 71.1 | 202.7 | 118.4 |
| M+S – G | 682.3 | 461.2 | 136.5 | 99.6 | 227.4 | 166.0 |
| Mgc – Br – Po | 612.4 | 351.5 | 122.5 | 76.7 | 204.2 | 127.7 |
| M + Ab – Ra – O | 686.5 | 397.5 | 137.3 | 86.2 | 228.8 | 143.6 |
| Mgc + Ub – C – Fb | 693.7 | 366.7 | 138.7 | 78.4 | 231.2 | 130.6 |
| Mgc + Rb – C – Bw | 695.4 | 343.5 | 139.1 | 76.7 | 231.8 | 127.8 |
| Mgc + Ab – Br – Ra | 679.4 | 344.2 | 177.1 | 75.8 | 432.5 | 126.4 |
| LSD (P=0.05) | 58.9 | 30.7 | 11.8 | 11.3 | 19.6 | 11.4 |

Table 4. Losses (%) in yield due to weeds (Mean of two years)

| Crop sequence | | Crop/season | | | | |
|---|---|---|---|---|---|---|
| | | *Kharif* | *Intercrop* | Rabi (I) | Rabi (II) | Overall |
| $C_1$ | M-W | 19.6 | | 42.2 | | 35.6 |
| $C_2$ | Mgc + Fb – P - Ss | 9.8 | 62.3 | 17.2 | 45.4 | 34.6 |
| $C_3$ | M+S – G | 20.0 | 43.7 | 19.0 | | 20.2 |
| $C_4$ | Mgc – Br – Po | 17.2 | | 40.9 | 35.8 | 34.5 |
| $C_5$ | M + Ab – Ra – O | 14.3 | 63.7 | 31.6 | 21.1 | 26.4 |
| $C_6$ | Mgc + Ub – C - Fb | 11.7 | 62.2 | 9.3 | 25.4 | 15.7 |
| $C_7$ | Mgc + Rb – C - Bw | 21.8 | 58.9 | 18.0 | 17.5 | 18.2 |
| $C_8$ | Mgc + Ab – Br - Ra | 23.9 | 62.0 | 19.2 | 25.4 | 22.9 |

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