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Effect of weed management on weed dynamics, growth and yield of barley (*Hordeum vulgare* L.) under *inceptisol* of western Uttar Pradesh

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Abstract
A field experiment was conducted with the aim to know effects of different weed management on weed density, growth, yield and yield attributes of transplanted rice in typic ustochrept soil during *rabi* 2016-17 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, U. P. (India). The experimental site was sandy loam in texture, low in organic carbon and available N, medium in available P and K and slightly alkaline in reaction. The experiment was laid out in randomized block design with three replications comprising eleven weed management treatments.
The results indicated that among the herbicides application of Sulphosulfuron + metsulfuron methyl @ 25+4 g a.i ha^{-1} significantly reduced the weed population and dry weight effectively over weedy check. The highest plant height, number of tillers m^{-2}, dry matter accumulation, 1000-grain weight and grain yield (44.18 q ha^{-1}) were recorded 42.96 per cent increase in grain yield over weedy check in barley crop with the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1}.Therefore,which established its superiority over rest of the herbicides. The application of Sulphosulfuron + metsulfuron methyl @ 25 +4 g a.i ha^{-1} resulted in to higher gross return, net return and B: C ratio. Thus the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} found better for sustainability of barley crop yield.

Keywords: Agronomic, herbicide, weed dynamics, weed management systems, productivity

Introduction
Barley is share of 7% of the global cereal production and third important cereal after rice and wheat in India Pal *et al.,* (2012). Globally barley was cultivated on nearly 51.50 million hectare area with a production of 142.01 million metric tons. In India, during 2016-17, Barley occupied nearly 7.72 lakh hectare area producing nearly 17.26 lakh tons grain, with a productivity of 2522 kg/ha Anonymus, (2017) [1]. The average productivity of barley in the state is far behind the attainable yielding of 40-50 q/ha Choudhary *et al.,* (2014) [3]. In recent years, the areas occupied by barley tend to decrease, caused by a series of economic, climatic and other factors. Retaining high and stable yields of barley required optimization all of processes in the technology of cultivation and consideration of climate changes. An important stage in the technology for growing is a crop protection and particular the fight against the weeds. Properly and timely destruction of the weeds guaranteed obtaining high yields of this crop. Registered in Uttar Pradesh a large number of herbicides in cereals with a different spectrum of activity and changes in weed infestation requires a study of the problem of the efficiency of the herbicides and herbicide combinations, and the sensitivity of the crop to them as well as to propose a cost-effective and efficient scheme for chemical control of weeds under certain conditions (Georgiev, 2015) [5].
The negative impact of individual species weed in cereals is determined by the combination of its features: period of germination, growth rate, size of the overhead mass, height and branching of stems, shape, size and position of leaves, levels of photosynthetic activity ecological plasticity coefficient of reproduction and others (Haigh, 2000) [6]. Bazitov *et al.* (2014) reported a significant increase in weed infestation in experimental areas of barley grown under irrigation. Manual and mechanical methods are laborious, tiresome and expensive due to increasing cost of labour, draft animals and implements and weed cannot effectively be managed merely due to crop mimicry. Therefore, the use chemical weed control has become necessary (Marwat *et al.*, 2008). Chemical weed control methods are most ideal, practical, effective, up to date, time saving and economical means of reducing early weed competition

and crop production losses (Ashiq *et al*., 2007). But, the exclusive reliance on herbicides has resulted in pollution of the environment and some weed species becoming resistant and inter and intra- specific shifts, integrating the chemical with cultural is an excellent option for weed control (Hassan and Marwat, 2001). Taking into consideration the necessity of chemical weed control for stable barley production, the objective of this study was to investigate the effectiveness of post herbicides and herbicide combinations for effective control of weeds in barley crop in the western Uttar Pradesh, India, and, at the same time, to estimate their influence on barley yields.

Materials and Methods

Experimental site

The field experiment was established in 2016-17 at Sardar Vallabhbhai Patel University of Agriculture &Technology, Meerut research farm ($29^0$4', N latitude and$77^0$42' E longitude a height of 237m above mean sea level) U.P., India. The region has a semi-arid sub-tropical climate with an average annual temperature of 16.8 ^{0}C. The highest mean monthly temperature (38.9 ^{0}C) is recorded in May, and the lowest mean monthly temperature (4.5 ^{0}C) is recorded in January. The average annual rainfall is about 665 to 726 mm (constituting 44% of pan evaporation) of which about 80% is received during the monsoon period. The predominant soil at the experimental site is classified as *Typic ustochrept*. Soil samples for 0–15 cm depth at the site were collected and tested prior to applying treatments and the basic properties were low available nitrogen, low organic carbon, available phosphorus, available potassium medium and alkali in reaction.

Experimental design and management

A detailed description of different weed management practices is necessary to compare the influence of weed management practices on environmental performance. Eleven weed management practices T_1- weedy check; T_2-Two hand weeding (25 & 50 DAS); T_3- Clodinofob (post emergence) @ 60g a.i. ha^{-1}; T_4-Sulphosulfuron (post emergence) @ 25g a.i.ha^{-1}; T_5- Clodinofob+2, 4-D (post emergence) @ 60 +500 g a.i.ha^{-1}; T_6- Sulphosulfuron + metsulfuron methyl (post emergence) @ 25+4 g a.i.ha^{-1}; T_7- Fenoxaprop (post emergence) @100g a.i.ha^{-1};T_8- Metribuzin (post emergence) @ 175 g a.i.ha^{-1}; T_9-Fenoxaprop+metsulfuron methyl (post emergence) @ 100+4 g a.i.ha^{-1};T_{10}- Carfentrazone ethyl (post emergence) @ 15g a.i. ha^{-1};T_{11}- Metsulfuron methyl (post emergence) @ 4ga.i.ha^{-1} in barley as Randomized block design and replicated thrice. The gross and net plot sizes were 6 m×5 m. Fertilizer application to the crop was done as per recommended fertilizer dose (RDF) for north region i.e. N;P_2O_5; K_2O (80-40-30 kg ha^{-1}). Half of the recommended dose of nitrogen, full dose of phosphorus and potassium were applied basally as per treatment before sowing. The remaining half nitrogen was applied after 1st irrigation. The sources of nitrogen, phosphorus and potassium were urea, DAP and MOP, respectively. Nitrogen, phosphorus and potassium were given through urea (46% N), di-ammonium phosphate (18% N & 46% P_2O_5) and muriate of potash (60% K_2O), respectively. The crop was sown at the rate of 80 kg seed per hectare irrespective of the treatments. The seed was placed at about 5 cm deep in furrows which were opened at 22.5 cm spacing of with the help of liner followed by light covering of seeds with soil.

Recommended package and practices were followed for the cultivation of barley except weed management. The herbicides were applied as per treatment details. The required quantity of herbicide were applied with manually operated knapsack sprayer fitted with flat-fan nozzle using a spray volume of 500 litre water / ha.

Observations Recorded

The number of individual weed present in the field was recorded at 30, 60 and 90 DAT. Different weed species present within three randomly selected 0.5 m x 0.5 m quadrate in each net plot area were counted and converted to number of weeds m-2 before subjecting to statistical analysis. Data on weed density and biomass were subjected to square-root transformation. The five plants were tagged at random in each plot and height of the shoot was measured at harvest. The height of each plant was measured from the base of the plant to the tip of the highest fully developed leaf before heading and up to tip of the spike after heading. Number of tillers was recorded by using a quadrate of one square meter from three places in each plot at harvest stage; average of three places was taken for analyses. Dry matter accumulation was recorded by selecting five hills randomly from observation row of each plot. Selected plants were cut carefully closed to the ground surface at harvest stage. After sun drying these samples were collected in paper bags by cutting in small pieces and were put in an electric oven at 60±1^{0}C till constant weight. After this the weight was recorded on electronic balance and expressed as dry matter accumulation in g m^{-2}.

Statistical analysis

Statistical analysis was performed by the Windows-based SPSS program (Version 10.0, SPSS, 1996, Chicago, IL). The SPSS procedure was used for analysis of variance to determine the statistical significance of treatment effects. Duncan’s Multiple Range Test (DMRT) was used to compare means through least significant difference (LSD).The 5.0% probability level is regarded as statistically significant.

Results

Effect on weed parameters

Total weed density

Density of total weeds was affected significantly by various treatments involving weed management practices (Fig. 1). Among weed control treatments significantly highest total weed density at 30, 60 and 90 DAS 11.7, 12.4 and 11.2 m^{-2}, respectively) was found under weedy check treatment. At 30, 60 and 90 DAS significantly lower weed density (4.8, 10.9 and 5.5 m^{-2}) were observed with two hand weeding. Among the different herbicidal treatments lowest density of total weeds was found with the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} and found statistically at par with Sulphosulfuron @ 25 g a.i ha^{-1} and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1}.

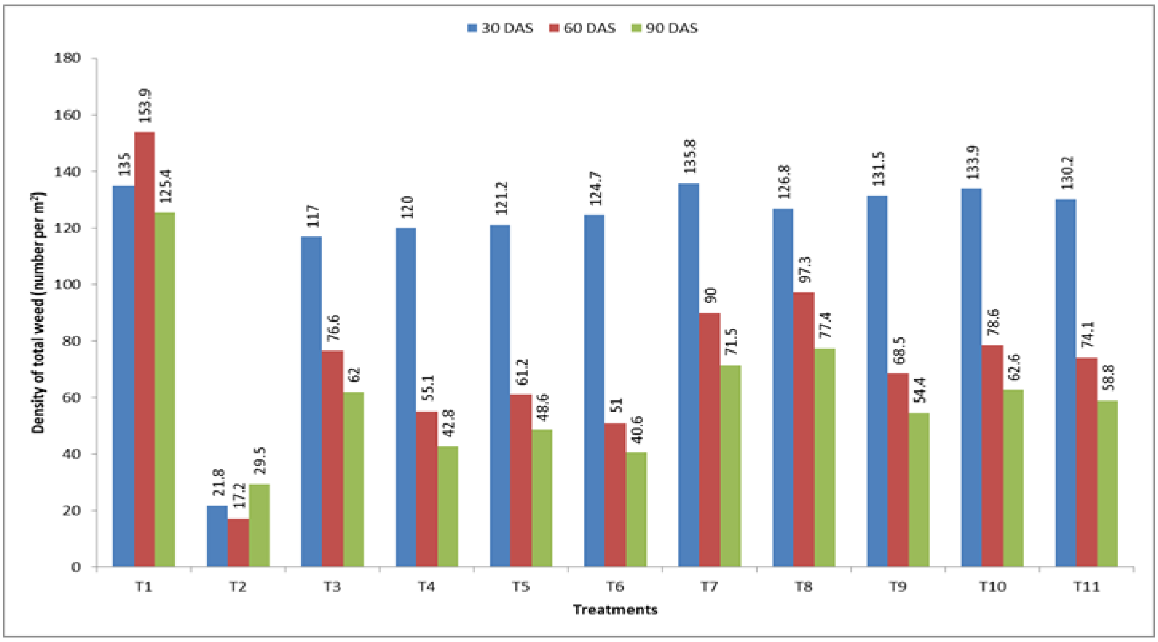


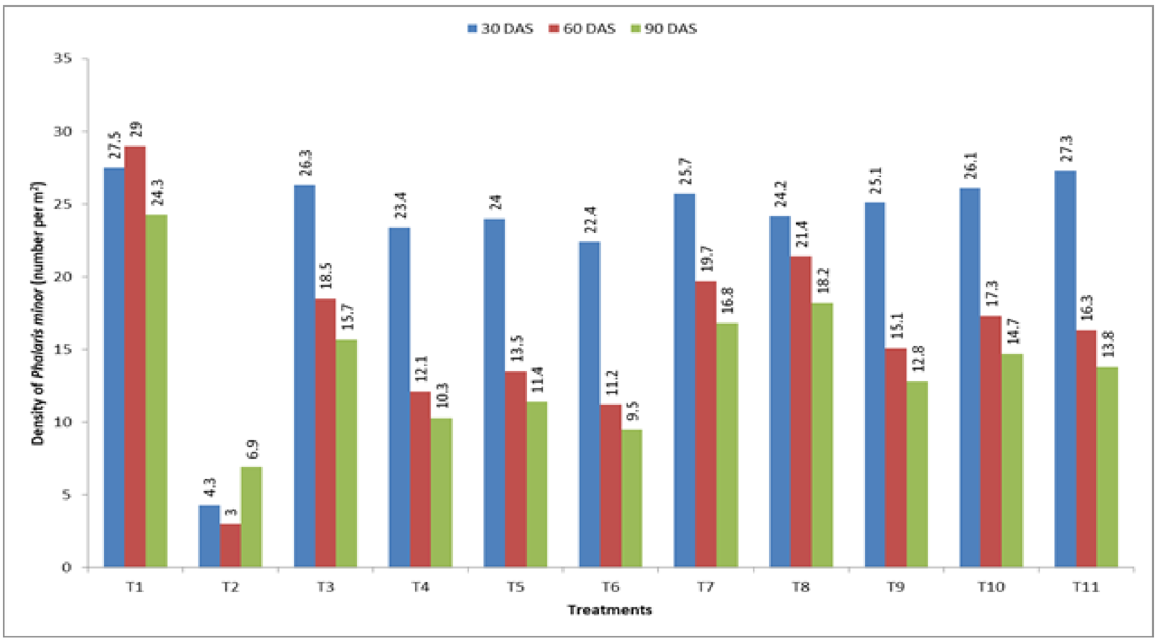
Fig 1: Effect of weed management practices on total weeds (m^{-2}) in barley at different stages

Density of *Phalaris minor* (m^{-2})

Density of *Phalaris minor* was affected significantly by various treatments involving weed management practices (Fig. 2a). Among weed control treatments significantly highest density of *Phalaris minor* 5.3, 5.5 & 5.0 m^{-2} was found in weedy check at 30, 60, and 90 DAS, respectively. However, the lowest weed density (4.8 m^{-2}) at 30 DAS was found in Sulphosulfuron + metsulfuron methyl @ 25+4 g a.i.ha^{-1} as compared to other weed control treatments. Among herbicide lowest weed density at 60 & 90 DAS 3.5 & 3.2 m^{-2} recorded in Sulphosulfuron+metsulfuron methyl @ 25+4g a.i.ha^{-1}, was found statistically at par with Sulphosulfuron @ 25 g a.i ha^{-1} (3.6 and 3.3 m^{-2}) and Clodinofob+2, 4-D @ 60+500 g a.i ha^{-1} (3.8 and 3.5 m^{-2}), respectively.

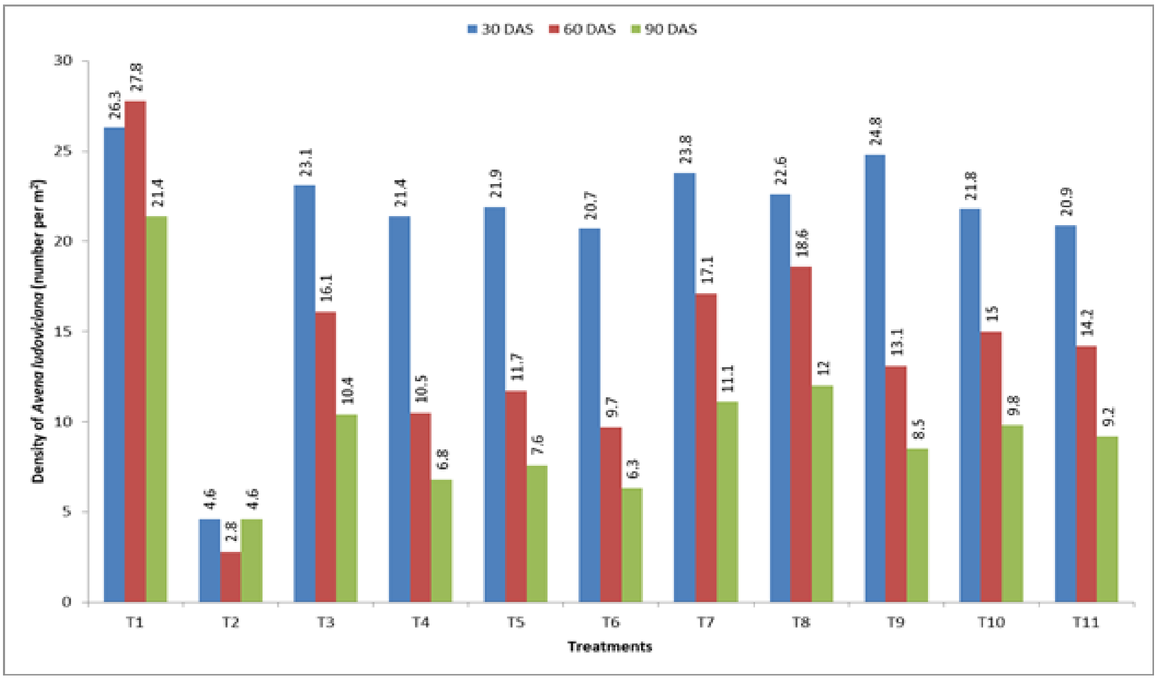
Density of *Avena ludoviciana*

Density of *Avena ludoviciana* was affected significantly by various treatments involving weed management practices (Fig. 2b). Among weed control treatments significantly lowest density of *Avena ludoviciana* 5.2, 5.3, & 4.7 m^{-2} at 30, 60 and 90 DAS, respectively was found in weedy check. Among the herbicide at 30 DAS, the significantly minimum weed density of *Avena ludoviciana* 4.7 m^{-2} was found in Sulphosulfuron + metsulfuron methyl @ 25+4 g a.iha^{-1} than rest of the treatments. At 60 DAS the significantly lowest weed density (3.3 m^{-2}) with the application Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was statistically at par with Sulphosulfuron @ 25 g a.i ha^{-1} and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} (3.4 and 3.6 m^{-2}) respectively while at 90 DAS, the significantly minimum density of *Avena ludoviciana* 3.1 m^{-2} found under Sulphosulfuron + metsulfuron methyl @ 25+4 g a.i ha^{-1} was statistically at par with Sulphosulfuron @ 25 g a.i ha^{-1}, Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} and Fenoxaprop + Metsulfuron methyl @ 100 + 4 g a.i ha^{-1} (3.1, 3.3 and 3.4 m^{-2}) respectively.



(a)

Fig 2 (a): Effect of weed management practices on density of *Phalaris minor* (m^{-2}) in barley at different stages



(b)

Fig 2(b): Effect of weed management practices on density of *Avena ludoviciana* (m^{-2}) in barley at different stages

Density of *Anagallis arvensis* (m^{-2})

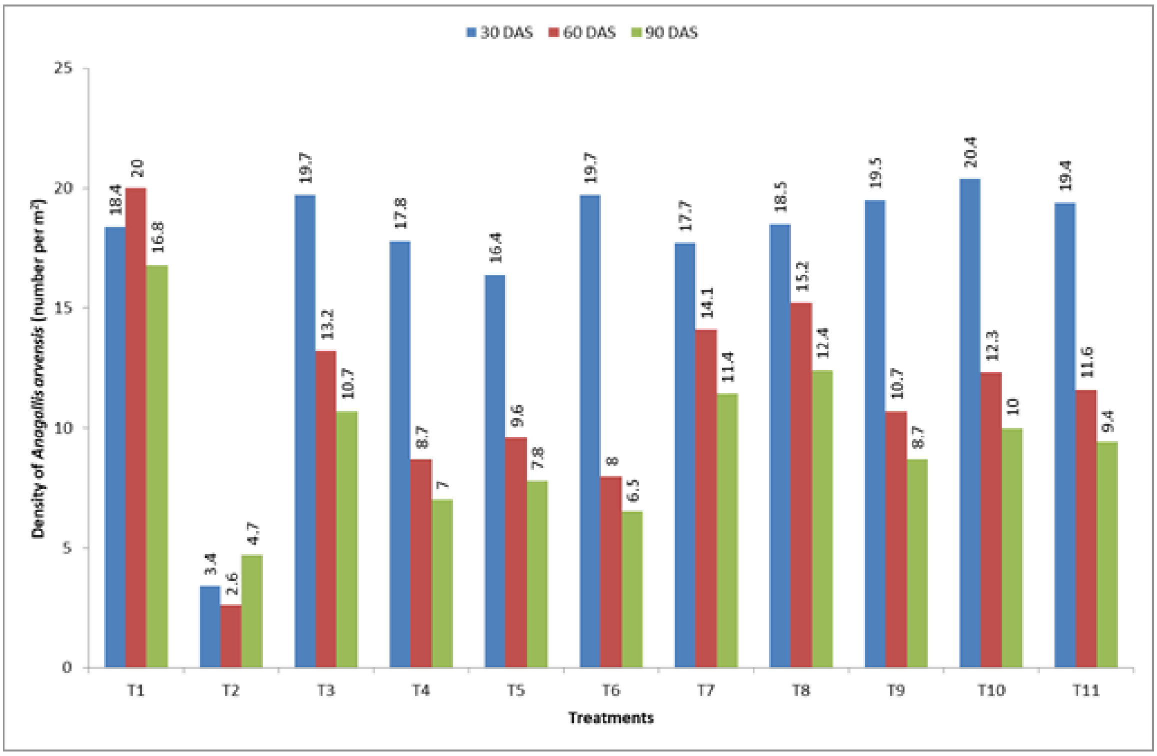
Density of *Anagallis arvensis* was affected significantly by various treatments involving weed management practices (Fig. 3a). Among weed control treatments significantly highest density of *Anagallis arvensis* (4.4, 4.6 & 4.2 m^{-2}) was found in weedy check at 30, 60 and 90 DAS respectively. Among the herbicide at 30 DAS the density of *Anagallis arvensis* recorded (4.2 m^{-2}) was lowest under the Clodinofob+2,4-D @ 60+500 g a.i ha^{-1} except all other treatments. At 60 and 90 DAS significantly minimum density of Anagallis *arvensis* (3.0&2.7 m^{-2}) recorded under the Sulphosulfuron + metsulfuron methyl @ 25+4 g a.iha^{-1} was statistically at par with Sulphosulfuron @ 25 g a.i ha^{-1} (3.1 & 2.9 m^{-2}) and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} (3.3 & 2.9 m^{-2}) respectively.

Density of *Chenopodium album* (m^{-2})

Density of *Chenopodium album* was affected significantly by various treatments involving weed management practices (Fig. 3b). Among weed control treatments significantly highest density of *Chenopodium album* (5.2, 5.4 & 4.7 m^{-2}) was found in weedy check, at 30, 60 and 90 DAS respectively. Among the herbicide At 30 DAS the density of *Chenopodium album* was lowest found (5.1m^{-2}) under the Clodinofob +2, 4-D @ 60+500 g a.iha^{-1} as compared to best of the treatment and at 60 DAS significantly lowest density of *Chenopodium album* (3.1 m^{-2}) found under the Sulphosulfuron+ metsulfuron methyl @ 25+4 g a.i ha^{-1} was statistically at par with Sulphosulfuron @ 25 g a.i ha^{-1} (3.2 m^{-2}) and Clodinofob+2,4-D @ 60+500 g a.i ha^{-1} (3.4 m^{-2}). At 90 DAS the significantly lowest density (2.9 m^{-2}) under the Sulphosulfuron+metsulfuron methyl @ 25+4 g a.i ha^{-1} was found lowest weed density was statistically at par Sulphosulfuron @ 25 g a.i ha^{-1} and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} (2.9 & 3.1 m^{-2}) respectively.

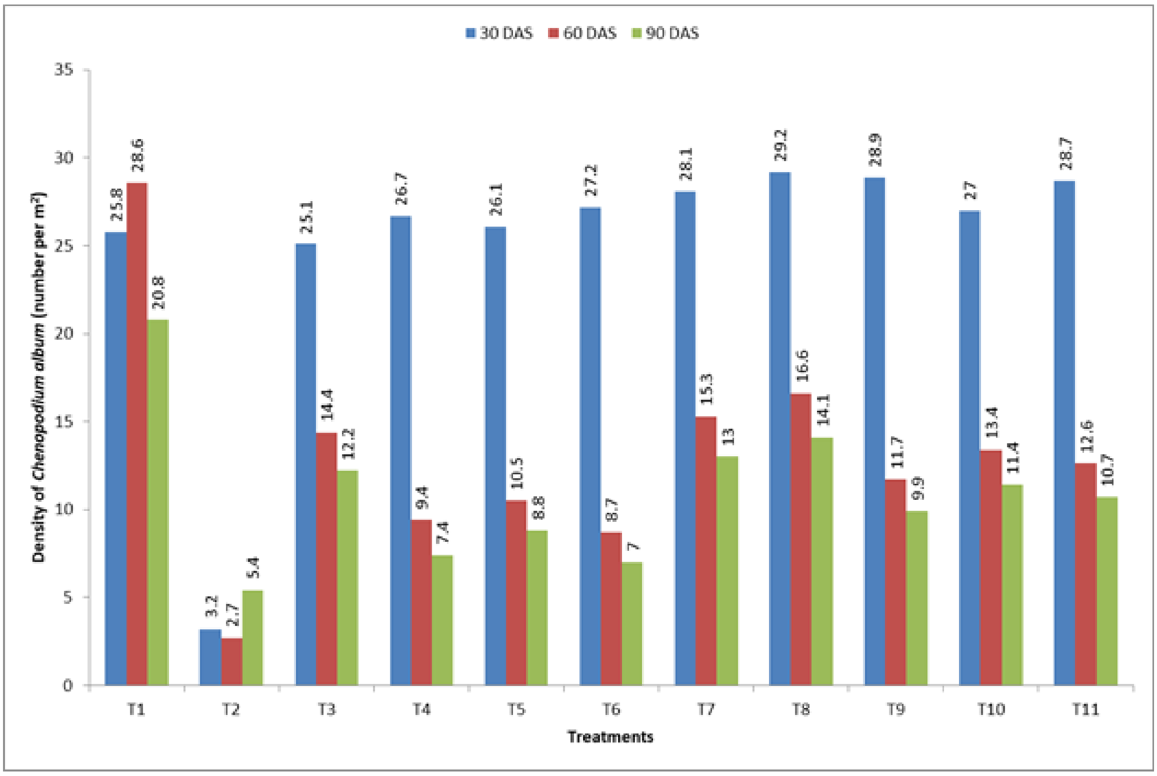
Density of *Melilotus indica* (m^{-2})

Density of *Melilotus indica* was affected significantly by various treatments involving weed management practices (Fig. 4a). Among weed control treatments significantly highest density of *Melilotus indica* (4.1, 5.0 & 4.6 m^{-2}) was found in weedy check at 30, 60 and 90 DAS respectively. Among the herbicide at 30 DAS the lowest weed density of *Melilotus indica* was recorded (4.0 m^{-2}) under the Sulphosulfuron @ 25 g a.i ha^{-1} as compared to rest of the treatments. at 60 DAS, the significantly minimum density of *Melilotus indica* density (2.8 m^{-2}) found in Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was at par with Sulphosulfuron @ 25 g a.i ha^{-1} (2.9 m^{-2}), and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} (3.0 m^{-2}). At 90 DAS *Melilotus indica* density (2.6 m^{-2}) significantly lowest in Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was statistically at par to Sulphosulfuron @ 25 g a.i ha^{-1} (2.7 m^{-2}) and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} (2.8 m^{-2}).



(a)

Fig 3(a): Effect of weed management practices on density of *Anagallis arvensis* (m^{-2}) in barley at different stages

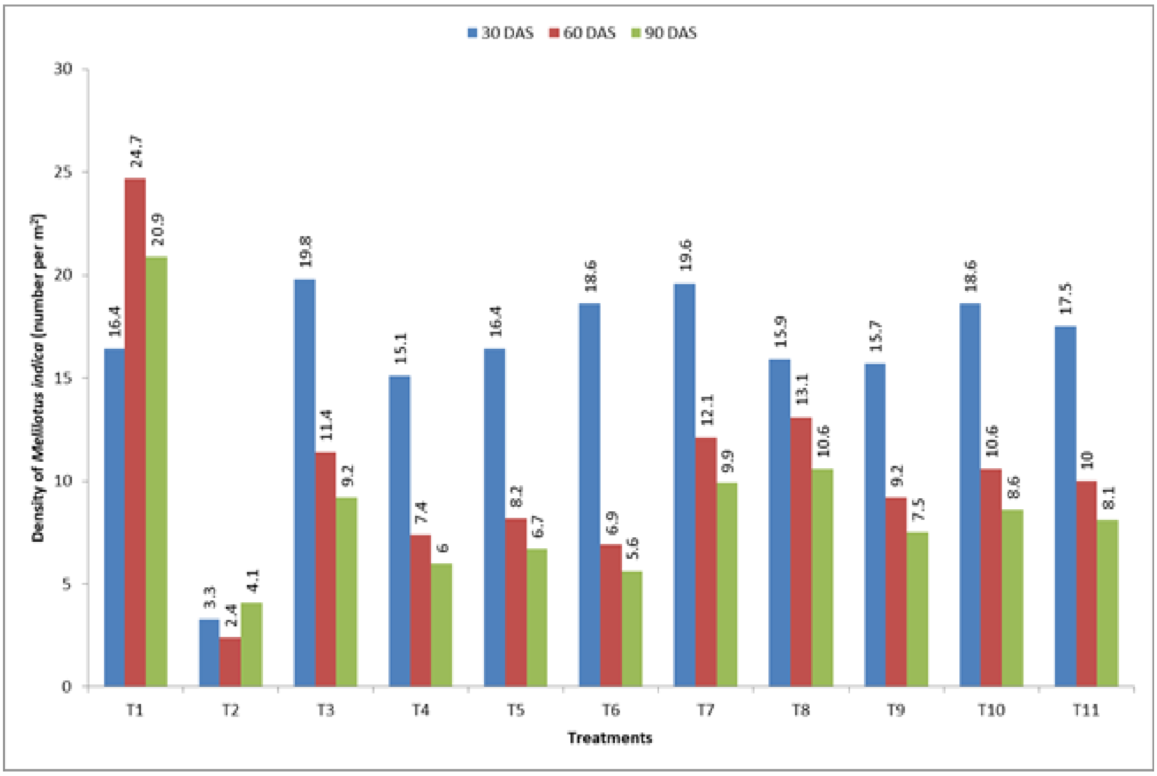


(b)

Fig 3(b): Effect of weed management practices on density of *Chenopodium album (*m^{-2}) in barley at different stages

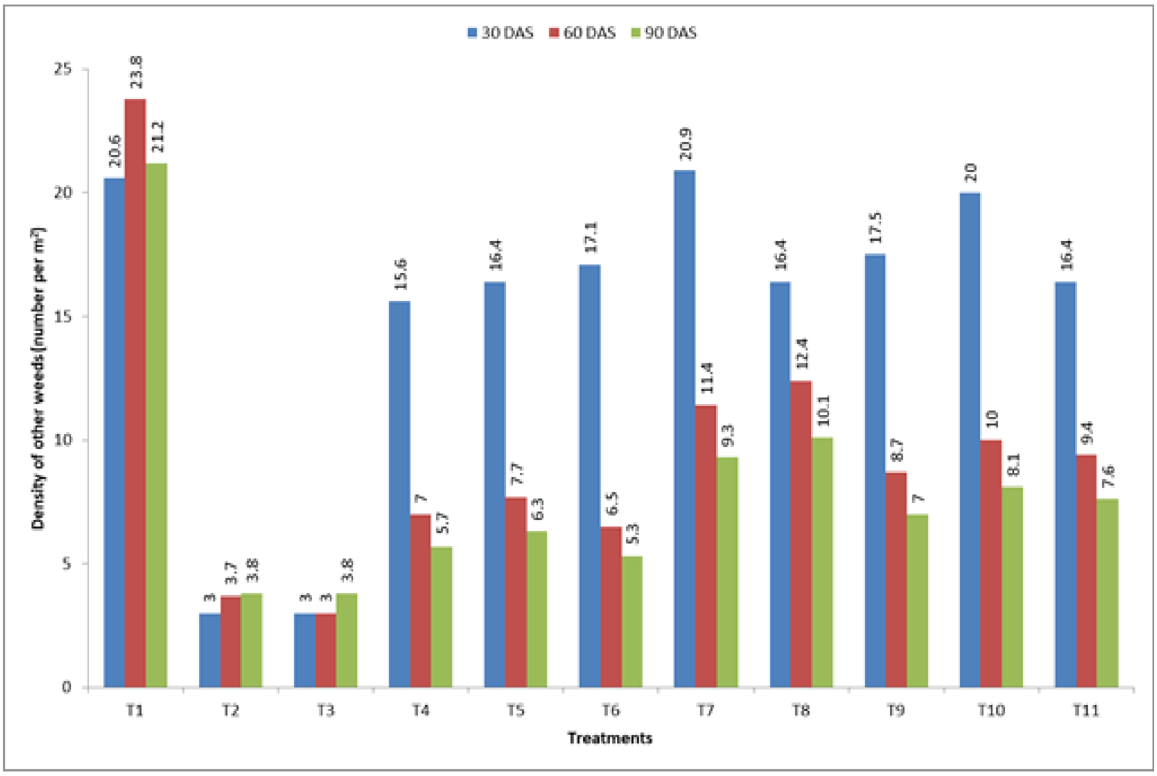
Weeds density of other weeds (m^{-2})

(Fig. 4b) revealed that other weeds were found in the barley field. Highest density (4.7, 4.9 & 4.7 m^{-2}) of other weed was observed in weedy check treatment at 30, 60 & 90 DAS respectively. Among the herbicide at 30 DAS the lowest density of other weeds was recorded (2.0 m^{-2}) under the treatment of Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} as compare to other treatments. At 60 DAS the density of other weeds (2.7 m^{-2}) was significantly minimum found under the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was at par to Sulphosulfuron @ 25 g a.i ha^{-1} (2.8 m^{-2}) and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} (2.9 m^{-2}).AT 90 DAS significantly lowest density of other weeds 2.5 m^{-2} found in Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was at par with Sulphosulfuron @ 25 g a.i ha^{-1}(2.6 m^{-2}) and Clodinofob + 2,4-D @ 60+500 g a.i ha^{-1} (2.7 m^{-2}).



(a)

Fig 4(a): Effect of weed management practices on density of *Melilotus indica* (m^{-2}) in barley at different stages

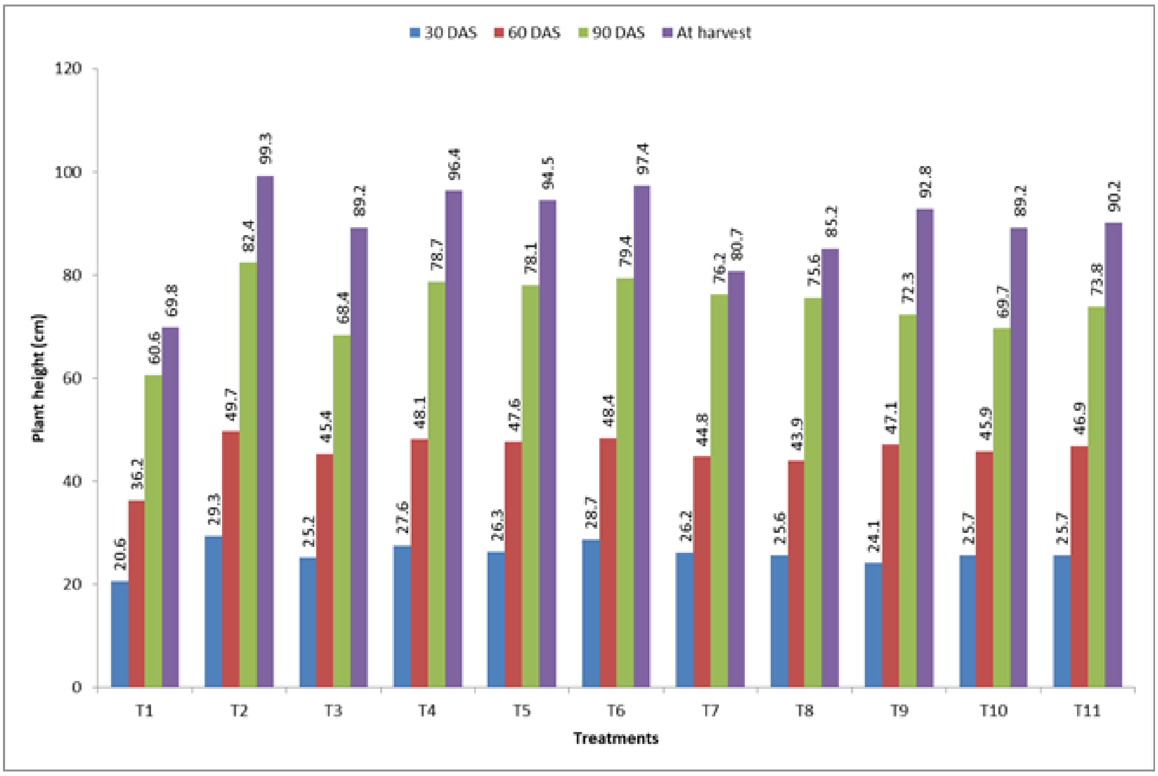


(b)

Fig 4(b): Effect of weed management practices on density of other weeds (m^{-2}) in barley at different stages

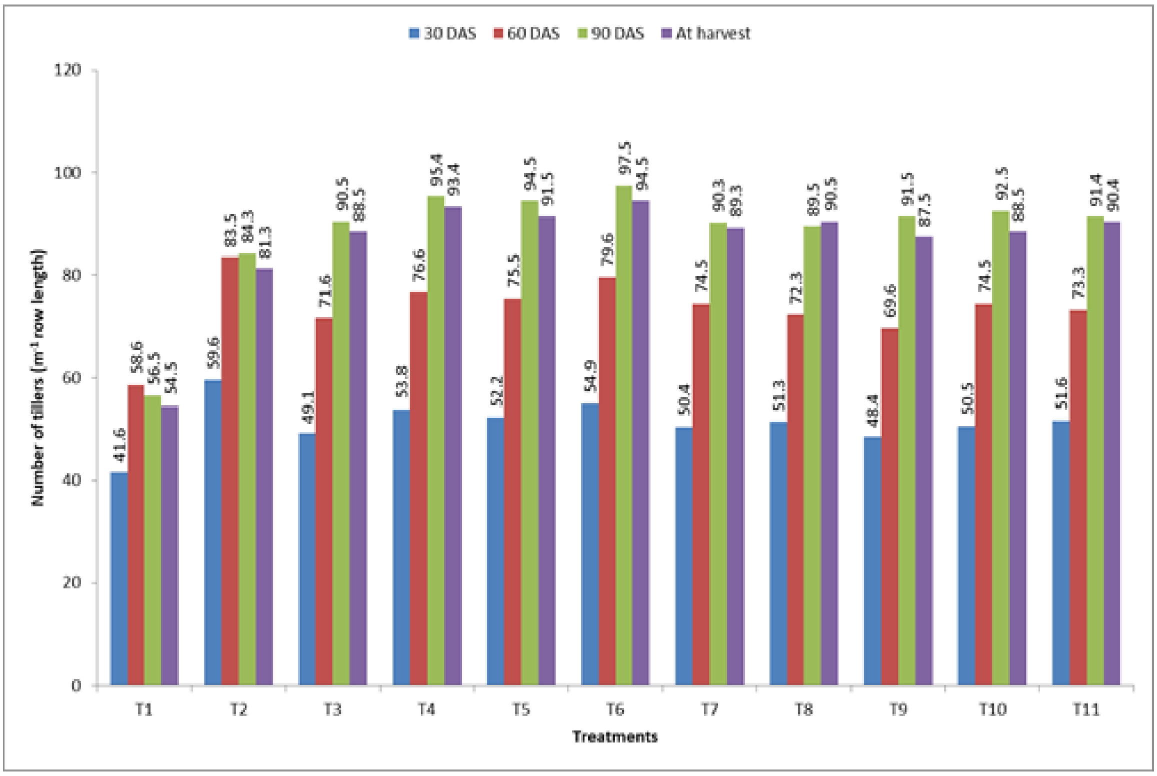
Effect on crop growth

Plant height, no of tillers and dry matter accumulation tended to increase with advancement in crop age, irrespective of the weed management practices (Fig. 5a, 5b & 5c). At harvest stage the significantly highest plant height, no of tillers and dry matter accumulation recorded in of Sulphosulfuron+metsulfuron methyl @ 25+4 g a.iha^{-1} which was at par with Sulphosulfuron @ 25 g a.i ha^{-1},Clodinofob+2,4-D @ 60+500 g a.iha^{-1}, Fenoxaprop+ Metsulfuronmethyl @ 100 + 4g a.i.ha^{-1}, Carfentazone ethyle @ 15 g a.i.ha^{-1} and Metsulfuron methyl @ 4 g a.i.ha^{-1} and significantly higher than the remaining treatments. Under weedy check plot lowest plant height, no of tillers and dry matter accumulation at 90 DAT and harvest stage recorded.



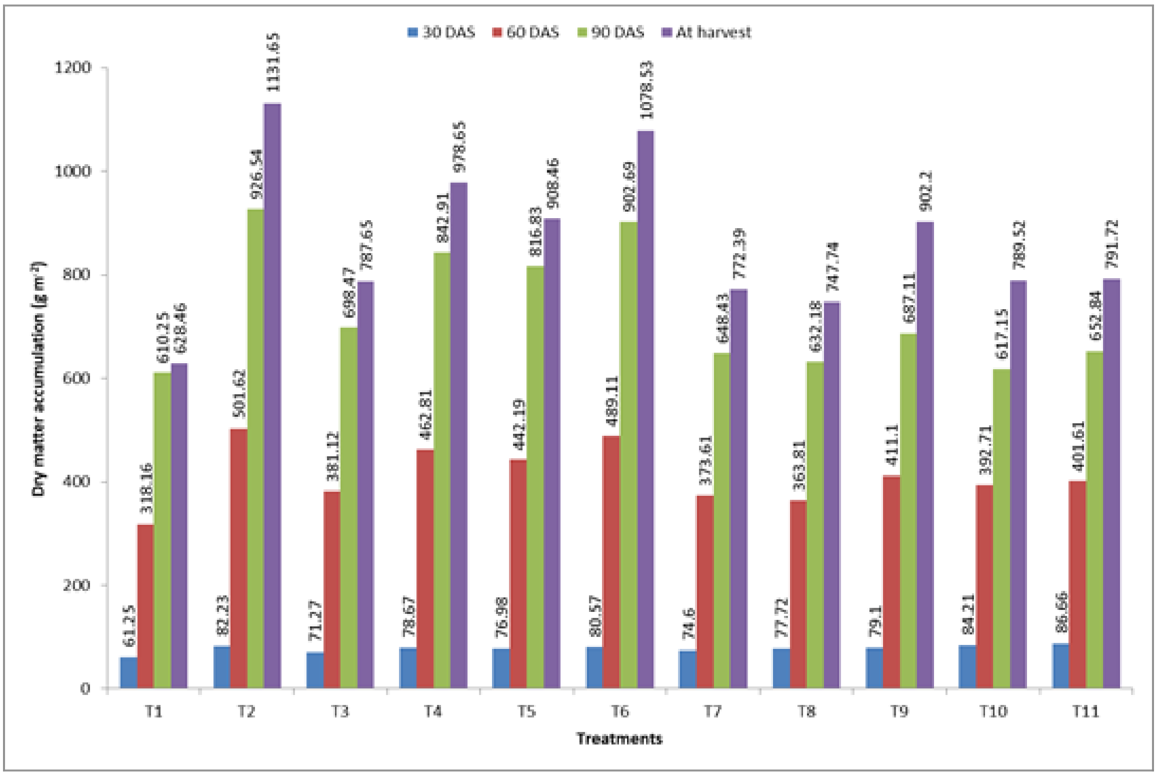
(a)

Fig 5(a): Effect of weed management treatment on Plant height (cm) in barley



(b)

Fig 5(b): Effect of weed management treatment on number of tillers in barley

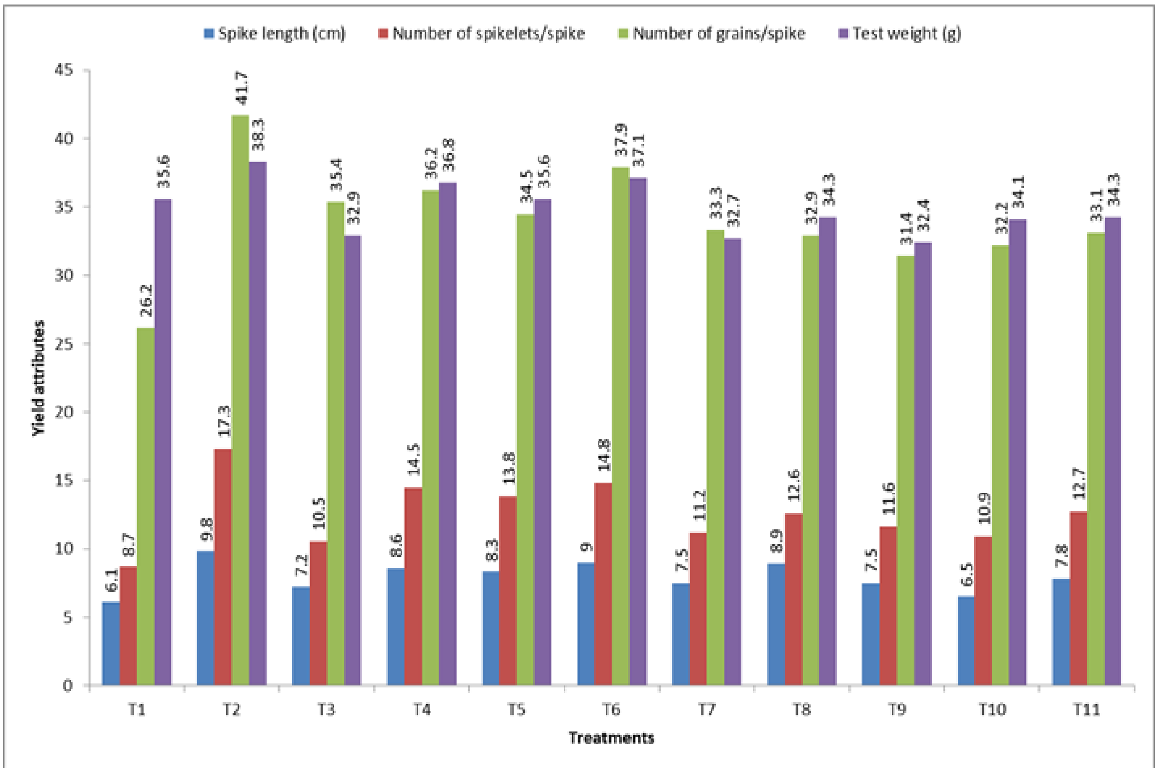


(c)

Fig 5(c): Effect of weed management treatment on dry matter accumulation (g m^{-2}) in barley

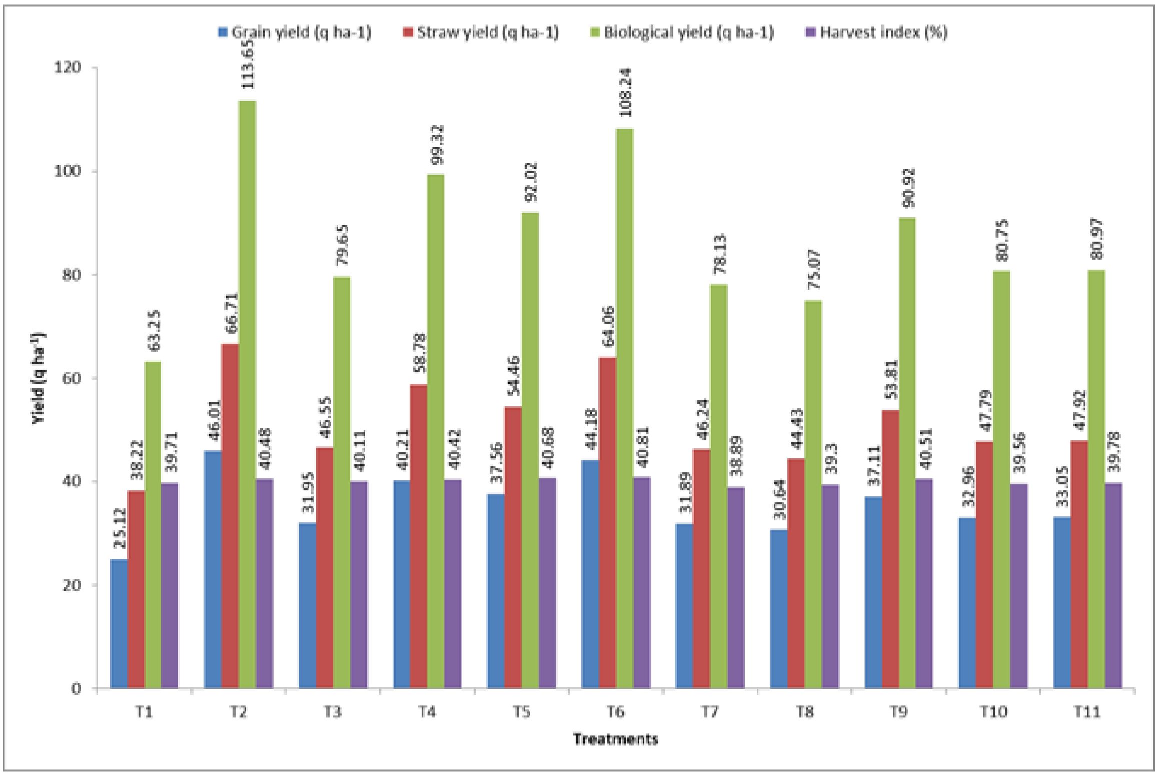
Effect on yield attributes and yield

The highest spike length, number of spikelets per spike, number of grains per spike, and test weight of grain was found in two hands weeding (Fig. 6a). Among the herbicides the highest spike length, number of spikelets per spike, number of grains per spike, and test weight recorded with the Sulphosulfuron+metsulfuron methyl @ 25 + 4 g a.i ha^{-1} were statistically atpar with Sulphosulfuron @ 25 g a.i ha^{-1}, Clodinofob + 2, 4-D @ 60+500 g a.i ha^{-1}, Metsulfuron methyl @ 4 g a.i ha^{-1}, Metribuzin @ 175 g a.i ha^{-1} and Carfentrazone ethyl @ 15 g a.i ha^{-1}. Sulphosulfuron + metsulfuron methyl @ 25 a.iha^{-1}.The lowest spike length, filled grain, unfilled grain and test weight of grain was found in weedy check.



(a)

Fig 6(b): Effect of weed management practices on grain yield, straw yield, biological yield and harvest index of barley



(b)

Fig 6(a): Effect of weed management treatments on length of spike (cm), spikelet's spike^{-1}, number of grain spike^{-1} and test weight (g) of barley

Grain yield

The highest grain yield 46.01 q ha^{-1} was found in two hands weeding and significantly higher to other treatments (Fig. 6b). Among the herbicides the highest grain yield 44.18 q ha^{-1} recorded with the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was significantly higher than rest of the treatments. Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} recorded (42.96%) higher grain yield over weedy check.

Straw yield (q ha^{-1})

Straw yield was affected significantly by various treatments involving weed management practices (Fig. 6b). Among weed control treatments the lowest straw yield (38.22 q ha^{-1}) found in weedy check was significantly lower than the remaining treatments. The highest straw yield (66.71 q ha^{-1}) was found in two hands weeding and significantly higher to other treatments. Among the herbicides the highest straw yield (64.06 q ha^{-1}) recorded with the application Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} which was higher than the rest of the treatments. Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} recorded (40.33%) higher straw yield over weedy check.

Biological yield

The highest biological yield 113.65 q ha^{-1} found in two hand weeding was statistically at par with Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} (Fig. 6b). Among the herbicides the highest biological yield (108.24 q ha^{-1}) recorded with the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} which was significantly higher than the rest treatments. Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} recorded (41.56%) higher biological yield over weedy check.

Harvest index

Harvest index was non-significantly affected by various treatments involving weed management practices. Among weed control treatments the lowest harvest index 39.71% was found in weedy check while the highest harvest index 40.48% in two hand weeding. Among the herbicides the highest harvest index (40.81%) recorded with the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} than rest of the treatments. Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} recorded (2.69%) higher harvest index over weedy check.

Discussion

The different chemical controls the weeds effectively as compared to weedy check. Significantly the lowest total weed population under two hand weeding treatment because two hand weeding treatment was kept of weeds free by hand weeding. Highest total weed density and number of different weeds species were recorded in weedy check plots due to unchecked growth of weeds which compete for all the resources up to maturity with crop. Two hand weeding plot proved to be the best treatment. Among the herbicides Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} found the best was at par with Sulphosulfuron @ 25 g a.i ha^{-1} to control weeds.

The maximum plant height, number of tillers m^{-2} and dry matter accumulation were recorded under two hand weeding treatment at different growth stage during experimentation. Among herbicides treatment Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was recorded the maximum plant height. This may be due to lower dry weight of weed in Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} applied plots followed by Sulphosulfuron @ 25 g a.i ha^{-1}, which resulted in less crop-weed competition. Furthermore, increased infestation of weeds showed negative influence on the crop growth as reflected in terms of lower initial plant height and plant biomass due to poor resource utilization (like nutrients uptake) at the critical period of crop-weed competition period i.e. 30-60 DAS. The possible reason of the maximum plant height in these treatments might be due to congenial and longer weed free environment during crop growth period provided better opportunity for overall growth and development of rice plants lead to maximum plant height. Klingman and Ashton (1982) [8] noted that application of Phenoxy herbicide at these stages can reduce plant height, delay maturity, and reduce grain yield due to inhibition of cell division and growth in the meristematic regions. However, in general, all the plots where herbicides, cultural and mechanical (alone or with herbicide) method applied to control weeds accumulated the higher dry matter of barley than un-weeded control. The possible reason of higher accumulation of dry matter of rice was the effect of herbicides on weeds so rice plant received more space, moisture, light and nutrient for their proper growth and this favoured the higher dry matter accumulation of rice per unit area. The higher dry matter accumulation also associated with the higher height and number of tillers. The increasing foliage might have enhanced the photosynthesis due to which plant dry matter accumulation was higher under these treatments. This is in accordance with the findings of Khaliq (2013) [7].

Spike length, spikelets spike^{-1}, number of grain spike^{-1} and test weight, was significantly influenced due to various weed management practices. Treatment Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was found superior as compared to all other weed management plots. The yield attributes are decided by genetic makeup of the crop and variety, but the agronomic manipulation also affects them to a great extent. The reproductive growth depends on vegetative growth of plant. More vegetative growth increases the photosynthetic area and supply of photosynthetic toward sink which decided the yield attributes and ultimately the yield. The higher values of yield attributes were due to increased synthesis and translocation of metabolites for the panicle development and grain formation. Besides, thousand grain weights were also maintained because of high mobilization of photo-synthesis from source to sink. However, this is quite possible because these combinations of herbicides might have been very effective to reduce the mixed weeds density and their growth resulting better and congenial environment favoured the barley plant to utilize nutrients, light, space luxuriantly and grew well to produce more number of tillers. Highest values of spike length, no. of spikelets grains spike-1, number /spike, grains weight/spike, spikes number /m2, grain and straw yields similar finding were reported by El-Metwally *et al*. (2010) [4]. The final yield of the crop was the cumulative effect of yield attributes and the factor which directly effect and or indirectly influenced them. A crop can performed best only when the display of foliage on the ground surface was in such a manner that utilizes maximum natural resources. In our study, grain yield ha-1 was significantly influenced by the different weed management practices. Treatment two hand weeding was superior in relation to grain yield ha-1 followed by Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} plots. Among the herbicide Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was superior in grain yield / ha and 43.14% higher grain yield over weedy check. This was might be due to the higher crop growth of barley in terms of foliage, large amount of photosynthesis, which act as source and helped in developing yield attributes due to low crop weed competition and finally the higher grain yield application of post emergence herbicide resulted in the highest grain yield. Shoeran *et al*. (2013) [9] reported that presence of weeds throughout the growing season brought about 37.2 and 33.1% reduction in grain yield as compared to weed-free check during 2006-07 and 2007-08, respectively.

Higher straw yield was due to more accumulation of dry matter m^{-2} along with highest plant height, and fnumber of tillers plant^{-1}.Treatment two hand weeding produced 3.97% higher straw yield over Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} due to better vegetative growth and more dry matter accumulation. The application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} was recorded straw yield (64.06 q ha^{-1}) which was (40.33%) higher as compared to weedy check plots. Highest values of spike length, grains number /spike, grains weight/spike, spikes number m^{-2}, grain and straw yields were obtained from similar findings were reported by El-Metwally *et al*. (2010) [4].

Conclusion

Based on the results of experimentation, it means that all weed control practices proved effective in controlling the weeds in barley and gave significantly higher grain yield over weedy. The application of Sulphosulfuron+ metsulfuron methyl @ 25+4 g a.i ha^{-1} most effective control weeds and weed dynamics,Moreover, highest growth parameters, yield attributes and yield of barley was noticed with the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1}. Among weed management treatments Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} found excellent to control weed population and increase yield attributes, yield. Thus the application of Sulphosulfuron + metsulfuron methyl @ 25 + 4 g a.i ha^{-1} found better for higher productivity of barley crop.

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