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Influence of weed management practices on weed control efficiency, growth and productivity of hybrid maize

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Abstract
A field experiment was conducted during *Kharif 2015* at Arkabahal Farm, Bhawanipatana Odisha, India to find out the most efficient and effective method of weed management in hybrid maize under rainfed condition. The treatments comprised of intercropping of maize + cowpea (1:1), maize + cowpea(1:1) with pre emergence application of pendimethalin @ 1 kg/ ha, pre emergence application of atrazine @ 1 kg/ ha either alone or with hand weeding at 30 days after sowing(DAS), pre emergence application of atrazine + pendimethalin @ (0.5 + 0.5) kg/ha followed by hand weeding at 30 DAS, hand weeding at 15 DAS and twice hand weeding at 15 and 30 DAS were compared with un weeded control. The results of experiment revealed that dry matter production of weeds, crop growth of hybrid maize in terms of plant height, number of leaves/plant, leaf area index and dry matter production along with yield attributes and yield were significantly influenced by the weed management treatments. The integrated use of pre-emergence application of herbicide combination of atrazine + pendimethalin (0.5 + 0.5) kg/ha and atrazine @ 1kg/ha with supplemented with hand weeding at 30 DAS in sole maize along with pendimethalin @ 1 kg/ha in intercropping of maize with cowpea remarkably reduced the weed dry matter accumulation and enhanced the weed control efficiency and crop growth parameters in terms of plant height, number of leaves/plant, leaf area index and dry matter production. The highest maize grain (5.67 t/ha) and stover yield (6.57 t/ha) were recorded in pre-emergence application of herbicide mixture of atrazine + pendimethalin (0. 5 + 0.5) kg/ha supplemented with hand weeding practice at 30 DAS. It remained at par with pre-emergence application of atrazine @ 0.5kg/ ha with hand weeding at 30 DAS in sole maize and pendimethalin @ 1 kg/ha in intercropping of maize + cowpea. The uninterrupted growth of weeds reduced the grain yield of maize to an extent of 68.11%.

Keywords: Hybrid maize, weed management, weeds control efficiency, growth, productivity

Introduction
Maize is the world's third most cereal crop after wheat and rice. Among the several constraints in maize cultivation, the most critical for the low yield is attributed to poor weed management. The weeds compete with crop for nutrients, soil moisture, sunlight and space throughout the vegetative stage and also during early part of the reproductive stage. The weeds competition with crop is resulted in reduction of photosynthetic efficiency, dry matter production and translocation of food material to economical part leading to poor grain yield. The growing of maize under wider row spacing and the slow initial crop growth are responsible for heavy weed infestation with grasses, sedges and broad leaved weeds during rainy season. The diverse weed floras inflict huge losses up to 60 per cent with season long weed infestation (Kumar et *al*. 2015) [2]. The critical period for crop weed competition in maize is between 15 to 45 days after sowing. During that period, weeds are required to be controlled effectively in order to realize the maximum production and return from the crop. The choice of weed management practices is fully depending upon it's effectiveness and economics. Timely weed control plays a decisive role in successful crop production. Weeds are effectively managed by feasible method of weed control such as preventive, physical, cultural and chemical. The manual weeding is not feasible as it is laborious, tedious, time consuming, costly and non availability of manpower during the peak period of weeding operation. However, among cultural practices, intercropping suppress weed better than sole cropping and reduces weeding cost. But alone, it is not sufficient to check the weed competition during initial period of crop growth.

That's why the weed control needs to be restored during initial period so that initial weed competition can be reduced. The pre emergence use of herbicides holds a key for early season weed control in the crops and cropping system. The pre-emergence application of atrazine is used as a common recommended practice of weed control in maize (Moinuddin *et al*. 2018) [3]. The use of pre emergence herbicides with low cost cultural method plays an important role to manage the weeds effectively and economically. Pre emergence application of pendimehalin in the intercropped maize with cow pea has been reported by Swetha *et al.* (2015) [7]. Pre emergence application of pendimethalin @ 1 kg/ ha with hand weeding (Shankar *et al*. 2015) [5], atrazine with hand weeding (Singh *et al*. 2015) [6] and herbicide combination of pendimethalin + atrazine are the effective way of weed management in corn (Shankar *et al.* 2015) [5]. Therefore, integrated weed management is the most preferable strategy to reduce the weed competition below economic injury level to achieve enhanced weed control efficiency, growth and productivity. Basing upon the above facts in view, the present investigation was under taken to find out an efficient method of weed management in hybrid maize.

Materials and Methods

The experiment was carried out at Arkabahal Farm, Bhawanipatana, Odisha, India during *kharif* 2015. The soil of the experimental field was sandy clay loam in texture and low in available N (123.45 kg/ha) and medium in available P (19.41 kg/ha) and potash (273 56 kg/ha). The experiment was comprised of eight treatments namely intercropping of maize with cowpea (1:1 ratio), pre emergence application of pendimethalin @ 1 kg/ ha at 1 day after sowing (DAS) in intercropping of maize with cowpea (1:1), pre emergence application of atrazine @ 1 kg/ ha at 1 DAS in sole maize, pre emergence application of atrazine @ 0.5 kg ha at 1 DAS followed by (Fb) hand weeding at 30 days after sowing (DAS) in sole maize, hand weeding at 15 DAS in sole maize, two hand weeding at 15 and 30 DAS in sole maize, pre emergence application of atrazine @ 0.5 kg/ ha + pendimethalin 0.5 kg/ ha at 1 DAS Fb hand weeding at 30 DAS in sole maize crop and un-weeded control. The experiment was laid out in complete randomized block design with three replications in the plot size of 5 m x 4.2 m. The maize variety Nirmal-51 and cowpea variety SFB – 2 was sown on 21th June with the spacing of 60 cm x 20 cm for maize and cow pea was sown in the middle of two rows of maize with plant to plant spacing of 15 cm. In the intercropped maize, 100% population of maize and 50% population of cowpea was maintained in the field. The maize crop was applied with fertilizer dose of 100kg N, 50kg P_2O_5 and 50 kg K_2O/ ha. The recommended dose of 20 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha was used for intercrop cowpea. All phosphatic and potassic fertilizer along with one third of recommended dose of nitrogen for maize and full nitrogen for cowpea were applied as basal at sowing in the furrows of the crop rows. The fertilizer sources were single super phosphate, urea and muriate of potash for both the crops. The pre emergence spraying of herbicides was done using knapsack sprayer with flat fan nozzle keeping spray volume of 500 litres/ ha. Hand weeding was done by labourers to the specific treatments at 15 and 30 DAS. The rest amount of nitrogen of the recommended dose was applied in equal splits both at knee high and tasseling stage of maize. Standard package of practices was followed throughout the cropping season. The weeds were uprooted from one m^2 area using the quadrant size of 1 m x 1m and dry weight was recorded after oven drying. The data on dry weight were recorded at 40 and 60 DAS and then the original values were subjected to square root transformation of $\sqrt{x}+0.5$ for statistical analysis where x signifies the original value. The weed control efficiency was calculated using the standard formula as given below.

$$\text{Weed control efficiency (WCE)} = \frac{X - Y}{X} \times 100$$

Where, X = Dry weight of weeds in un weeded plot and Y = Dry weight of weeds in treated plot.

The crop growth parameters with respect to plant height, number of leaves/ plant and dry weight were recorded from 10 plants from the net plot at harvest and mean values were taken. The leaf area was recorded from five plants per net plot selected randomly at harvest. The length and maximum width of each green leaf was measured and their mean values were taken for calculation of leaf area. The product of leaf length and breadth was multiplied by a factor 0.75 to calculate individual leaf area of a plant. Then it was multiplied with number of leaves /plant to find out the total leaf area of a plant. The average leaf area / plant were expressed in cm^2. The leaf area index (LAI) was calculated by the following formula as suggested by Watson, (1947) [8].

$$\text{LAI} = \frac{\text{Leaf area of plant}}{\text{Ground area covered by plant}}$$

The data on number of cobs/plant was taken from 10 randomly selected plants from the net plot. The number of rows /cob and number of grains/ cob were taken from 10 cobs harvested from each net plot. The mean values of each yield attributes were computed for statistical analysis. The harvested cobs from each net plot were threshed and dried perfectly for recording of grain weight along with 1000 grain weight. The plants from each net plot were harvested by sickle after plucking of cobs and stover weight was taken after perfect sun drying. The weed index was worked by from the following formula and expressed in percentage.

$$\text{Weed index} = \frac{YBT - YTC}{YBT} \times 100$$

Where, YBT= Yield of best treatment and YTC =Yield of treatment to be compared

Results and Discussion

Occurrence of weed flora in experimental site

The experimental site was infested with altogether 17 weed species consisting of 7 narrow leaved and 10 broad leaved weeds. The predominant narrow leaved weeds were *Dactyloctenium aegyptium*, *Digitaria ciliaris* followed by *Echonochloa colonum, Sporobolus diander, Eleusne indica, Cynodon dactylon and Cyperus rotundus. The Ageratum conyzoides, Borreria hispida, Commelina benghalensis, Cleome viscosa, Celosia argentea, Euphorbia hirta, Physalis minima, Phyllanthus niruri, Portulaca oleracea and Trianthema portulacstrum* were the most prevalent broad leaved weeds found invading the hybrid maize during *kharif* season.

Effect on total weed dry weight and weed control efficiency

The weed management treatments exerted the positive influence on total weed dry weight at 40 and 60 DAS. At 40 DAS, significantly the lowest weed dry weight was observed in pre emergence (PE) application of atrazine 0.5 kg/ha + pendimethalin @ 0.5kg/ha followed by (Fb) hand weeding (HW) at 30 DAS in sole maize (3.96 g m^2). It was followed by hand weeding at 15 and 30 DAS (4.51 g m^2) and atrazine@0.5kg/ ha (PE) Fb HW at 30 DAS (4.80 g m^2) under sole maize which were statistically at par. The latter treatment did not differ significantly from hand weeding at 15 DAS (5.07 g m^2) and pre emergence application of atrazine @ 1 kg/ ha (5.09 g/ m^2) when both applied in sole maize during 40 DAS. During 60 DAS, weed dry weight was remarkably reduced with combined PE application of atrazine + pendimethalin @ (0.5 + 0.5) kg /ha Fb HW at 30 DAS (3.28 g m^2) being at par with hand weeding done at 15 and 30 DAS (3.59 g m^2) in sole maize. It might be due to the fact that first and second flush of weeds were controlled with manual weeding and thereafter, the new flushes of weeds could not attain the full growth under the shade of crop canopy. Pre-emergence application with herbicide combination of atrazine + pendimethalin in reducing the weed dry weight was reported by Shankar *et al*. (2015) [3] and Gupa and Mishra, (2017) [1].

The next best treatments in reduction of weed dry matter accumulation at 60 DAS were atrazine @ 0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize (3.67 g/m^2) and pendimethalin@1kg/ha (PE) in maize + cowpea (3.84 g/m^2). Under intercropping system, the weed biomass was reduced due to herbicide use helping in reduction of weed population at early stage of crop growth and lack of availability of uncovered inter row spaces for weeds growth as already occupied by intercrop of cowpea at later stage of crop growth. Similar favourable effect of pre emergence application of pendimethalin in intercropped maize with cowpea was reported by Swetha et al. (2015) [7]. The maximum dry matter of weeds were recorded under uninterrupted growth of weeds giving the values of 9.48 and 10.22 g m^2 respectively at 40 and 60 DAS, respectively.

The weed control efficiency was appreciably influenced by weed control treatments at 40 and 60 DAS (Table 1). The maximum weed control efficiency was recorded in herbicide combination of atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW at 30 DAS (82.99%) followed by hand weeding at 15 and 30 DAS (77.78%) in sole maize at 40 DAS. During 60 DAS, same treatments i.e. the herbicide combination of atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW at 30 DAS gave the highest weed control efficiency (82.99%) closely followed by hand weeding at 15 and 30 DAS (88.05%), atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in (87.47%) in sole maize and pendimethalin@1kg/ha (PE) in maize + cowpea intercropping (86.43%). The WCE signifies the comparative magnitude of response in reduction of weed dry matter by different weed control treatments. The herbicide combination of atrazine + pendimethalin supplemented with hand weeding, atrazine +hand weeding, pre-emergence application of pendimethalin in intercropped maize increased the WCE which were comparable with twice hand weeding treatment. The reduction in weed dry matter in those treatments resulted in improvement of WCE. This is attributed to control of weeds efficiently during early stages of crop growth by pre- emergence application of herbicides followed by removal of weeds in inter and intra rows at later stages of crop growth. Similar favourable effect of atrazine with hand weeding (Samanta *et al*. 2015) [4] and herbicibe combination of atrazine + pendimethalin (Shankar *et al*. 2015) [3] in enhancing the WCE is supported by earlier findings reported by several research workers.

Effect on growth

The crop growth parameters like plant height, dry matter accumulation, number of leaves /plant and leaf area index were significantly affected by weed management practices at harvest (Table 2). The tallest plants were produced in maize with pre emergence application of pendimethalin @ 1.0 kg/ha in the intercropping of maize with cowpea (189.12 cm). It was at par with atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW (30 DAS) which did not differ significantly from atrazine @ 0.5kg/ ha (PE) Fb HW at 30 DAS (180.20 cm) in sole maize. The pre emergence application of pendimethalin @ 1.0 kg/ha in the intercropping of maize with cowpea recorded the maximum number of leaves/ plant in maize (13.09) which was at par with atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW at 30 DAS (12.82) and hand weeding at 15 and 30 DAS(12.66) in sole maize. The number of leaves/ plant in maize with atrazine@0.5kg/ ha (PE) Fb HW at 30 DAS (12.44) was not significantly different from hand weeding at 15 and 30 DAS in sole maize. Intercropping of maize with cowpea applied with pre emergence application of pendimethalin @ 1.0 kg/ha enhanced the leaf area index of maize (2.74). It remained at par with atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW at 30 DAS (2.67) and hand weeding at 15 and 30 DAS (2.63) in sole maize. The highest dry matter accumulation was resulted in pre emergence application of atrazine @ 0.5kg DAS + pendimethalin @ 0.5kg DAS Fb HW at 30 DAS (14.05 t/ha) which was at par with pre-emergence of application of pendimethalin @ 1.0 kg/ ha in maize + cowpea recording the dry matter accumulation of 13. 44 t/ha. All the growth parameters were increased in the integrated weed management treatments due reduction in weed growth and completion which ultimately supplied the growth factors for better crop growth and development. This result is in pipe line with the results of Shankar *et al*. (2015) [3] and Gupta and Mishra, 2017 [1].

Effect on yield attributes in maize

The weed management practices markedly influenced by the yield parameters like number of cobs/plant, number of rows/cob, number of grains/cob and 1000 grain weight (Table 3). Pre -emergence application of pendimethalin @ 1 kg/ha in intercropping of maize + cowpea produced the maximum number of cobs/ plant (1.29). It was closely followed by atrazine + pendimethalin@ (0.5+0.5) kg /ha with hand weeding at 30 DAS (1.27) and atrazine@ 0.5 kg kg/ ha (PE) Fb HW at 30 DAS (1.22) in sole maize which were at par with the former treatment. The number of rows per cob was significantly enhanced in atrazine + pendimethalin Fb hand weeding (13.90) which was at par with intercropping of maize + cowpea applied with pendimethalin (13.32) and atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize (13.00). The maximum number of grains/ cob was recorded in atrazine + pendimethalin Fb by hand weeding at 30 DAS (462) being at par with intercropped maize applied with pendimethalin @ 1 kg/ha (432.04 and atrazine @ 0.5 kg /ha with hand weeding at 30 DAS (431.67). The pre emergence application of atrazine @ 0.5 kg/ha Fb hand weeding at 30 DAS recorded the highest 1000 grain weight of maize (270.18

g). It remained at par with atrazine + pendimethalin (0.5 + 0.5) kg/ha Fb by hand weeding at 30 DAS (265.43 g), pendimethalin @ 1 kg/ha in the intercropping of maize (265.12 g) and hand weeding at 15 and 30 DAS (263.11g). The enhancement in yield attributes by those treatments is due to the fact that low weed dry matter accumulation and reduced weed competition along with increase in weed control efficiency that influenced the availability of all growth factors to express better yield attributes. Hence, increase in growth parameters by those treatments resulted in better interception of sunlight and increase in photosynthetic efficiency in conjunction with efficient translocation of photosynthate from source to sink thereby increased the yield parameters. This result in agreement with findings of Shankar *et a*l. (2015) [3], Samanta *et al*. (2015) [4] and Gupa and Mishra, (2017) [1]. The yield attributes were reduced in un-weeded control compared with all other weed management treatments.

Effect on yield, harvest index and weed index in maize

The grain and stover yield of maize was significantly influenced by the weed management treatments (Table 4). Pre-emergence application of herbicide mixture of atrazine + pendimethalin (0.5 + 0.5) kg/ha Fb by hand weeding at 30 DAS produced the highest maize grain yield (5.67 t/ha). It remained at par with atrazine @ 0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize (5.51 t/ha), pendimethalin @1kg/ha (PE) in maize + cowpea (5.45 t/ha) and hand weeding at 15 and 30 DAS in sole maize (5.43 t/ha). The stover yield of maize was maximum in herbicide mixture of atrazine + pendimethalin@(0.5 + 0.5) kg/ha Fb by hand weeding at 30 DAS (6.57 t/ha) which was statistically at par with pendimethalin@1kg/ha (PE) in maize + cowpea (6.52 t/ha) and atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize. The stover yield in hand weeding at 15 and 30 DAS (6.01t/ha) was found at par with with pendimethalin@1kg/ha (PE) in maize + cowpea (6.52 t/ha) and atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize. The hand weeding at 15 and 30 DAS recorded the highest harvest index (47. 46%) followed by atrazine@0.5kg/ ha (PE) Fb HW at 30 DAS (46.59%) and herbicide mixture of atrazine + pendimethalin (0.5 + 0.5) kg/ha Fb by hand weeding at 30 DAS (46.33%) in sole maize. The minimum reduction in yield was observed in atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize (2.93%) followed by hand weeding at 15 and 30 DAS (4.34%) and Pendimethalin@1kg/ha (PE) in maize + cowpea (5.56%). The yield is function of dry matter production, efficient translocation of photosynthates from source to sink for accumulation in storage organ and yield components. The enhancement of yield attributing traits by those treatments reflected the grain yield of maize. Similar favourable effect of pre-emergence application of atrazine with hand weeding (Samanta *et al*. 2015) [4] and pre-emergence application of pendimethalin in maize with cowpea intercropping (Swetha *et al.* 2015) [7], and herbicide combination of pendimethalin + atrazine (Gupta and Mishra, 2017) [1] on yield of maize was obtained by several research workers.

The maximum harvest index was registered by twice hand weeding treatment (47.46%) followed by atrazine with hand weeding (46.59%) and pendimethalin + atrazine with hand weeding at 30 DAS (46.33%). The uninterrupted growth of weeds caused reduction in grain yield of maize to the tune of 68.11% while comparing with the best treatment obtained with herbicide mixture of atrazine + pendimethalin (0.5 + 0.5) kg/ha Fb hand weeding at 30 DAS applied in sole maize.

Table 1: Weed dry weight and weed control efficiency as influenced by weed management treatments at different days after sowing (DAS) in hybrid maize.

Treatments	Weed dry weight (g/m^2)		Weed control efficiency (%)	
	40 DAS	60 DAS	40 DAS	60 DAS
Maize + cowpea (1:1 ratio)	*6.92 (47.41)	*6.24 (38.45)	46.93	63.06
Pendimethalin@1kg/ha (PE) in maize + cowpea (1:1 ratio)	*5.18 (26.32)	*3.84 (14.26)	70.54	86.30
Atrazine @ 1 kg/ ha (PE) in sole maize	*5.09 (25.44)	*4.44 (19.20)	71.52	81.55
Atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize	*4.80 (22.53)	*3.67 (13.04)	74.78	87.47
Hand weeding at 15 DAS in sole maize	*5.07 (25.26)	*4.89 (23.44)	71.73	77.47
Hand weeding at 15 and 30 DAS in sole maize	*4.51 (19.85)	*3.59 (12.44)	77.78	88.05
Atrazine@0.5kg/ha + pendimethalin@0.5kg/ha (PE) Fb HW (30 DAS) in sole maize	*3.96 (15.19)	*3.28 (10.30)	82.99	90.102
Un weeded control in sole maize	*9.48 (89.34)	*10.22 (104.07)	—	—
SE (m) ±	0.10	0.11	—	—
CD (P=0.05)	0.32	0.32	—	—

* Transferred value = $\sqrt{x}$+0.5 where x = original value given in parenthesis
Pre emergence (PE), Followed by (Fb), Hand weeding (HW)

Table 2: Effect of weed management treatments on plant height, number of leaves/plant and leaf area index dry matter accumulation, of hybrid maize at harvest.

Treatments	Plant height (cm)	Leaves /plant	LAI	Dry matter (t/ha)
Maize + cowpea (1:1 ratio)	171.4	11.74	2.09	10.74
Pendimethalin@1kg/ha (PE) in maize + cowpea (1:1 ratio)	189.12	13.09	2.74	13.43
Atrazine @ 1 kg/ ha (PE) in sole maize	175.27	11.84	2.46	12.61
Atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize	180.20	12.44	2.39	13.95
Hand weeding at 15 DAS in sole maize	176.09	11.33	1.92	9.64
Hand weeding at 15 and 30 DAS in sole maize	30.24	12.66	2.63	12.66
Atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW (30 DAS) in sole maize	187.22	12.82	2.67	14.05
Un weeded control in sole maize	165.60	8.35	1.82	7.82
SE (m) ±	2.46	0.18	0.07	0.40
CD (P=0.05)	7.47	0.55	0.23	1.21

* Transferred value = $\sqrt{x}$+0.5 where x = original value given in parenthesis
Pre emergence (PE), Followed by (Fb), Hand weeding (HW)

Table 3: Effect of weed management treatments on yield attributes of hybrid maize

Treatments	Cobs/ plant	Rows/ cob	Grains/ cob	1000 grain weight (g)
Maize + cowpea (1:1 ratio)	1.14	12.30	348.88	262.22
Pendimethalin@1kg/ha (PE) in maize + cowpea (1:1 ratio)	1.29	13.32	432.04	265.12
Atrazine @ 1 kg/ ha (PE) in sole maize	1.18	11.73	368.17	261.17
Atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize	1.22	13.00	407.66	270.18
Hand weeding at 15 DAS in sole maize	1.08	11.96	362.92	249.23
Hand weeding at 15 and 30 DAS in sole maize	1.10	12.66	431.67	263.11
Atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW (30 DAS) in sole maize	1.27	13.90	462.03	265.43
Un weeded control in sole maize	0.87	10.87	200.92	200.92
SE (m) ±	0.06	0.34	16.54	5.71
CD (P=0.05)	0.18	1.12	50.17	17.44

Pre emergence (PE), Followed by (Fb), Hand weeding (HW),

Table 4: Grain yield, stover yield, harvest index and weed index as influenced by weed management treatments.

Treatments	Grain yield (t/ ha)	Stover yield (t /ha)	Harvest index (%)	Weed index (%)
Maize + cowpea (1:1 ratio)	4.00	5.61	41.66	30.55
Pendimethalin@1kg/ha (PE) in maize + cowpea (1:1 ratio)	5.45	6.52	45.53	5.56
Atrazine @ 1 kg/ ha (PE) in sole maize	4.39	5.86	42.81	16.82
Atrazine@0.5kg/ ha (PE) Fb HW (30 DAS) in sole maize	5.51	6.31	46.59	2.93
Hand weeding at 15 DAS in sole maize	3.83	4.92	43.75	34.34
Hand weeding at 15 and 30 DAS in sole maize	5.43	6.01	47.46	4.34
Atrazine + pendimethalin@ (0.5 + 0.5) kg /ha (PE) Fb HW (30 DAS) in sole maize	5.67	6.57	46.33	—
Un weeded control in sole maize	1.74	4.01	30.28	68.11
SE (m) ±	0.12	0.17	-	-
CD (P=0.05)	0.36	0.51	-	-

Pre emergence (PE), Followed by (Fb), Hand weeding (HW),
@0.5kg/ha+ pendimethalin@0.5kg/ha (PE) Fb HW (30 DAS) in sole maize

Conclusion

It is inferred that pre-emergence application of either herbicide combination of atrazine with pendimethalin (0.5 + 0.5 kg)/ha or atrazine @ 1.0 kg/ha in sole maize along with pre-emergence application of pendimethalin @ 1.0 kg/ha in intercropping of maize with cowpea supplemented with hand weeding at 30 days after sowing are found effective way of weed management in hybrid maize.

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