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Efficacy evaluation of selected herbicides on weed control and productivity evaluation of *Bt* cotton in Punjab

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Abstract

Field experiments were conducted during *Kharif* 2012 and 2013 to evaluate the efficacy of different herbicides for weed management in cotton. Highest seed cotton yield (3537.3 kg ha^{-1}) was recorded in weed free plots followed by pendimethalin @1.0kg a.i ha^{-1} as Pre.em.+quizalofopethyl @50g a.i ha^{-1} post-em at 2-4 weed leaf stage + one hoeing (3318.9 kg ha^{-1}) owing to improved number of bolls per plant and boll weight. Statistically least yield was recorded under weedy check (1435.4 kg ha^{-1}). Application of pyrithiobac sodium could not express any visible toxic effect on crop indicating its selectivity for cotton, although none of the tested new chemicals *i.e.*, pyrithiobac sodium@ 62.5g a.i ha^{-1} and quizalofopethyl @50g a.i ha^{-1} when applied alone could not outperform the existing recommended chemicals for weed management. Yield losses to the extent of 6.2-59.4% were recorded due to weed competition. Weed control efficiency (WCE) was highest under weed free check (86.8%) followed by pendimethalin @1.0kg a.i ha^{-1} as Pre. em.+quizalofopethyl @50g a.i ha^{-1}, at 2-4 weed leaf stage + one hoeing (73.7%) , whereas minimum values were for weedy check (24.7%). Though net returns (₹94660 ha^{-1}) were highest for weed free check but higher B:C ratio (2:11) was observed for pendimethalin @1.0kg a.i ha^{-1} as Pre em.+quizalofopethyl @50g a.i ha^{-1} post-em at 2-4 weed leaf stage+one hoeing . Therefore, for reasons such as labor shortage besides their timely availability, using these herbicides in combination with cultural practices could be the practical solution for economically efficient and effective weed management.

Key words

Herbicide, Seed cotton yield, Sympods, Weed control efficiency

Introduction

Cotton is an important cash crop of India owing to its pivotal role in agriculture, industrial development and employment generation. It is sensitive to weed competition during initial growth stages due to slow growth and wider spacing. Weeds compete for nutrients, water, light and thus reduce cotton yield substantially (Bukun, 2004 and Iftikhar *et al.*, 2010). Being heavily fertilized/manured and often irrigated are also among the factors responsible for heavy weed infestation (Bishnoi *et al.*, 1993). In case of heavy rains, providing timely weed control becomes difficult as soil becomes sticky and wet leading to poor workability while in dry soil, the surface becomes hard making inter-row cultivation difficult. Also, non-availability of human labour for weeding makes timely weed control tedious and uneconomic. Use of herbicides is considered the most effective method of controlling weeds in cotton but after the effect of herbicide is over, the weeds grow again particularly during the rainy/monsoon season. Nalayini and Kandasamy (2001) reported that pre-emergence herbicides can manage weeds only up to 30 DAS and controlling late emerging weeds in cotton is really a challenge. Application of post emergence herbicides to supplement pre-emergence treatments may give desired season long weed control in cotton (Dadari and Kuchinda, 2004). As hardly any selective broad-spectrum post emergence herbicide is available for cotton, farmers perform several hand weeding and inter culture operations to control weeds which add to the cost of production. Choice of herbicides for broad-spectrum weed control and at the same time delaying the development of herbicide resistance in weeds is also equally crucial. Though rotating herbicides with different modes of action to delay the development of resistance in weeds has been advocated (Vargas and Wright, 2005) as repeated use herbicides of same chemical class may result in the development of herbicide resistance in weeds (Heap, 2007). Moreover, it may cause environmental and human health hazards (Judith *et al*., 2001). This necessitates the development of integrated weed-management strategies comprising both cultural and chemical control to manage weeds throughout the crop growing period and increasing yield (Panwar *et al.,* 1995; Brar *et al.,* 1998; Blaise and Ravindran, 2003 and Ali *et al.,* 2005). Khan *et al*. (2001) also reported that application of pendimethalin and oxadiazon significantly reduced the weed density and increased cotton yield. With increasing availability of new chemicals, their efficiency and efficacy for managing weeds needs to be evaluated for guiding cotton growers. Singh *et al.* (2013) reported that cotton growers are keen to improve profit margins by adopting improved cotton production practices while maintaining yield. At present, no documented study is so far available which show quantitative effects of the studied new molecules such as Quizalofopethyl (Targa Super) and company acclaimed selective herbicide i.e Pyrithiobac sodium (Hitweed) for cotton under semi arid agro-ecosystem of north India. Generation of such information through field experimentation under site-specific conditions is therefore very crucial. The present field investigations evaluated the efficacy of pre-emergence (Pre-em.), pre-plant incorporated (PPI) and selective post emergence (Post-em.) herbicides alone and in combination with cultural practices for effective and efficient weed management in cotton.

Materials and Methods

The experiment was conducted during *Kharif* 2012 and 2013 at PAU, Regional Research Station, Faridkot which lies in Trans-Gangetic agro-climatic zone, representing the Indo-Gangetic alluvial plains of Punjab situated 200 m above MSL. The soil of the experimental field was loamy sand, normal (pH 8.7), EC (0.20dS^{-m}), O.C (0.33 %), medium in available P (14 kg/ha) but high in available K (555 kg ha^{-1}). The experiment comprising 10 weed management treatments (*i.e* T_1: Pendimethalin @ 1.0 kg a.i ha^{-1} as Pre em. + one hoeing, T_2: Trifluralin @ 1.2 kg a.i ha^{-1} PPI + one hoeing,T_3: Quizalofopethyl @50 g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing,T_4: Pendimethalin @1.0kg a.i ha^{-1} as Pre em.+Quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing,T_5: Pyrithiobac sodium @ 62.5g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing, T_6: Pyrithiobac sodium @ 62.5g a.i/ha + Quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing,T_7: Glyphosate @ 1.0kg a.i ha^{-1} as directed spray at 45 DAS,T_8: Weed free check,T_9: Farmer's practice and T_{10}: Weedy check/Control) was conducted in randomized block design having four replications. Hand hoeing in all the treatments was given at 60 DAS while, in Farmer's practice, one hand hoeing at 60 DAS followed tractor hoeing at 90 DAS and application of glyphosate @0.5kg a.i ha^{-1} was done as directed spray to emerged weeds during rainy season.

Total amount of rainfall was 223.6 and 870.1 mm for the year 2012 and 2013, respectively. Number of rainy days (33) were higher during 2013 as compared to only 28 days in 2012.A maximum temperature of 40.7ºC was recorded in June 2012, while May (39.5ºC) was the hottest month in 2013. Sowing was performed during the third week of May in both years. *Bt* hybrid MRC7017BGII was planted on well prepared seed bed at a uniform inter row spacing of 67.5 cm while intra row spacing of 75 cm was maintained. The recommended fertilizer dose (*i.e.*, 75kg N, 30kg P_2O_5 and 50kg K_2O ha^{-1}) was applied as per package of practices. Trifluralin was applied as PPI, by dissolving in 500 l ha^{-1} of water on a well prepared seedbed before sowing and incorporated with *Karandi* in the upper 3-4 cm of soil. Pre-emergence herbicide pendimethalin was sprayed just after sowing, using a hand operated knapsack sprayer fitted with flat fan nozzle. Other herbicides were sprayed as post emergence after mixing with water (@250 l ha^{-1}) and delivered uniformly using knapsack sprayer. All other practices were followed as per the recommended package of practices. Weed population and biomass was recorded from quadrat measuring 50 cm × 50 cm and expressed per square meter. Above-ground biomass of weeds was taken from a random unit area of 1m^2 and oven dried at 80°C to a constant value for recording dry weight. Data on growth, yield and other parameters were recorded from five randomly selected plants in each treatment plot while seed cotton yield (SCY) was recorded from the whole plot. The data were analyzed statistically using SAS Proc to test the significance. The least significant difference (LSD) at 5% probability level was used for comparing differences among the treatment means and pooled means.

Results and Discussion

Maximum plant height among various weed control treatments (Table 1) was recorded in weed free check plots (126.8cm), followed by T_5 *i.e.,* pyrithiobac sodium @ 62.5 g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing (125.8cm), while statistically minimum was noted for weedy check (102.5cm). This might be due to early canopy closure of weeds over crop suppressing vertical and lateral growth. Sandangi and Barik (2007) and Nadeem *et al.* (2013) also reported similar results. Highest monopods per plant (2.7) were recorded in weed free check though it was statistically at par with T_1 (2.5), T_4 (2.4), T_5 (2.4), T_6 (2.4) and T_9 (2.5) but statistically superior to rest of the treatments. The significantly least number of monopodial branches per plant (1.8) was recorded in weedy check. However, our results are in agreement with Nadeem *et al.* (2013) who have attributed differences in genetic makeup of crop plants and type of weed control practices as the reasons. Sympods per plant were also highest in weed free check (33.7) followed by T_6 *i.e.*, pyrithiobac sodium @ 62.5g a.i ha^{-1} + quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing (31.3) and T_4 i.e pendimethalin @1.0kg a.i ha^{-1} as Pre em. +quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing (30.4) over rest of the treatments.

Table 1 : Growth parameters of *Bt* cotton under different weed management treatments

Weed management	Plant height (cm)			Monopods/plant			Sympods/plant			Biomass (q ha^{-1})			Plant stand ha^{-1}		
	2012	2013	pooled	2012	2013	pooled	2012	2013	pooled	2012	2013	pooled	2012	2013	pooled
T_1:Pendimethalin@ 1.0 kg a.i ha^{-1} as Pre emr+one hoeing	112.9	128.0	120.5	2.1	3.0	2.5	12.5	39.5	26.0	91.5	107.0	99.2	18874	19362	18995
T_2: Trifluralin@1.2 kg a.i ha^{-1} PPI + one hoeing	121.2	117.5	119.3	2.0	2.4	2.2	15.1	31.4	23.2	111.1	96.4	103.7	18383	18137	18015
T_3: Quizalofopethyl@ 50 g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing	131.3	121.5	126.4	1.8	2.8	2.3	13.3	39.8	26.6	93.1	109.4	101.3	19037	18382	18914
T_4: Pendimethalin@1.0kg a.i ha^{-1}+Quizalofopethyl @50g a.i ha^{-1} + one hoeing	124.2	123.5	123.4	2.0	2.8	2.4	17.3	44.0	30.6	125.8	119.4	122.6	18874	18995	18750
T_5:Pyrithiobac Sodium@ 62.5g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing	125.2	126.4	125.8	2.2	2.5	2.4	12.3	38.2	25.2	83.3	98.0	90.6	18220	19240	18505
T_6:Pyrithiobac Sodium@ 62.5g a.i ha^{-1}+Quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage +one hoeing	122.9	124.8	123.9	2.3	2.6	2.4	14.6	48.1	31.3	101.3	108.6	104.9	18710	19240	18832
T_7: Glyphosate@1.0kg a.i ha^{-1} as directed spray at 45 DAS	108.5	122.0	115.3	1.6	2.3	2.0	10.5	35.1	22.8	88.2	93.1	90.6	19037	18259	18342
T_8: Weed free check	126.1	127.5	126.8	2.5	3.0	2.7	18.6	48.7	33.7	133.9	124.3	129.1	18547	19607	19159
T_9: Farmers practice	119.7	126.3	123.0	2.0	3.0	2.5	11.8	35.1	23.5	86.6	104.5	95.5	18874	19117	18832
T_{10}:Weedy check/Control	94.8	110.2	102.5	1.5	2.1	1.8	10.0	22.5	16.2	71.8	84.9	78.3	18874	18627	18914
LSD (0.05)	**11.1**	**5.3**	**4.5**	**NS**	**0.5**	**0.3**	**1.72**	**7.92**	**3.9**	**19.6**	**18.9**	**13.1**	**NS**	**NS**	**NS**

This might be due to the favourable conditions that existed during early growth period due to low weed population, resulting in vigorous crop development leading to higher number of sympods per plant. As a result of this, significantly higher biomass was recorded in case of weed free plots (129.1q ha^{-1}) as compared to all the tested treatments except for T_4 *i.e.*, pendimethalin @1.0kg a.i ha^{-1} as Pre em.+quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing (122.6 q ha^{-1}) with which it was at par. Statistically least biomass was recorded under weedy check (78.3q ha^{-1}) because of maximum competition offered by weeds (Table 1). Similarly, plant stand also exhibited non-significant differences for population which might have been due to the use of uniform seed rate and thinning at early growth stages to maintain plant to plant distance. Nadeem *et al.* (2013) also reported that herbicides produced non-significant effect on cotton plant population. Highest number of bolls per plant (65.7) and improved boll weight (4.48g) resulted in significantly better seed cotton yield (3537.3 kg ha^{-1}) in weed free check (Table 2) over all the tested treatments except T_4 *i.e.*, pendimethalin @1.0kg a.i ha^{-1} as Pre em.+ quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing (3318.9 kg ha^{-1}). Least seed cotton yield (1435.4 kg ha^{-1}) was recorded in weedy check because of severe weed competition due to the reason that weed population (78.0) and weed dry weight (362.8g) was highest (Table 3). Decrease in yield under weedy check was probably due to increased crop-weed competition and poor nutrient availability to crop plants which have been reflected in reduced yield contributing parameters such as boll number and boll weight. Panwar *et al.,* (1995) and Rajeswari and Charyulu (1996) also reported that weed control practices increased the number of sympods, bolls per plant, boll weight and yield. The reduced yield in case of Farmer's practice (2398.5 kg ha^{-1}) was due to reduction in yield attributing parameters owing to higher weed population causing severe intra-row weed-crop competition during the reproductive phase of crop. Panwar *et al.,* (1999), Tanveer *et al.,* (2004) and Sandangi and Barik (2007) also reported that weed control treatments reduced weed infestation and increased seed cotton yield. The present studies revealed yield losses in the range of 6.2-59.4% due to competition offered by weeds to cotton crop over the tested treatments.

Dry weight of weeds is an important measure showing the extent to which weeds have competed with the main crop and how weed growth has been affected by weed control practices. Non-significant differences for initial weed count and dry matter indicated uniformity among treatment plots. Results revealed that dry weight of weeds as influenced by different weed management practices, had significant effect on the number and dry weight of weeds with significantly least values for weed free check plots (Table 3). The results further indicated that among herbicidal

Table 2 : Yield and yield contributing characters of *Bt* cotton under different weed management treatments

Weed management	Seed cotton yield (Kg ha^{-1})			Bolls/plant			Boll weight (g)			Weed control efficiency (%)		
	2012	2013	pooled	2012	2013	pooled	2012	2013	pooled	2012	2013	mean
T_1:Pendimethalin@1.0kg a.i ha^{-1} as Pre emr+one hoeing	2696.0	2786.5	2741.3	43.2	59.1	51.1	4.13	4.12	4.13	38.1	45.7	41.9
T_2: Trifluralin@1.2 kg a.i ha^{-1} PPI+one hoeing	3219.3	2661.5	2940.4	53.0	48.6	50.8	4.24	4.10	4.17	40.4	41.3	40.9
T_3:Quizalofopethyl@50 g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing	2968.1	2673.2	2820.6	48.6	55.7	52.2	4.35	4.05	4.20	46.9	43.5	45.2
T_4: Pendimethalin@1.0kg a.i ha^{-1}+Quizalofopethyl @50g a.i ha^{-1} +one hoeing	3411.7	3226.1	3318.9	57.3	68.4	62.8	4.50	4.22	4.36	70.4	76.9	73.7
T_5: Pyrithiobac sodium@ 62.5g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing	2462.5	2722.4	2592.4	39.5	51.2	45.3	4.26	4.06	4.16	31.4	39.6	35.5
T_6: Pyrithiobac sodium@ 62.5g a.i ha^{-1}+Quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing	3105.3	3037.8	3071.6	52.0	63.4	57.7	4.27	4.16	4.21	58.9	64.5	61.7
T_7:Glyphosate@1.0kg a.i ha^{-1} as directed spray at 45 DAS	2327.4	2334.1	2330.8	37.3	43.4	40.3	3.83	4.12	3.98	35.1	34.3	34.7
T_8: Weed free check	3651.9	3422.6	3537.3	61.5	70.0	65.7	4.53	4.44	4.48	93.2	80.3	86.8
T_9: Farmers practice	2486.5	2309.6	2398.5	42.6	45.0	43.8	3.71	3.92	3.81	19.0	30.3	24.7
T_{10}:Weedy check/Control	1370.0	1500.8	1435.4	27.0	28.2	27.6	3.20	3.47	3.34	-	-	-
LSD (0.05)	**391.9**	**363**	**261.4**	**8.4**	**7.56**	**5.5**	**0.55**	**0.4**	**0.33**	**-**	**-**	**-**

treatments minimum dry weight (93.6 g) of weeds in case of pendimethalin @1.0kg a.i ha^{-1} as Pre em.+quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing, while maximum dry weight was observed in weedy check (362.8g). Highest dry weight of weeds was observed in weedy check because weeds were allowed to compete with crop throughout the season, accumulating more photosynthates and dry matter. While minimum weeds dry weight after weed free check (51.5g) was recorded in plots where cotton was sown and applied with T_4 *i.e.*, pendimethalin @1.0kg a.i ha^{-1} as Pre em. + quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing to control weeds owing to less weed population accumulating less dry matter (93.6g). Maximum weed population was observed in weedy check (78.0) because weeds were allowed to grow and compete with crop throughout the season. Significantly minimum weed population in weed free plots might have been due to the reason that manual hoeing removed the weeds and chances of establishment of new weeds were reduced because of smothering effect of cotton. These results were in accordance with those of Khan and Khan (2003), Naseer-ud-Din *et al.* (2011) and Shahzad *et al.* (2012) who reported that hand weeding and herbicidal treatments reduced weed infestation efficiently. Iqbal and Cheema (2008) and Nadeem *et al.* (2013) also reported significant reduction in weed population due to weed control practices over check. Least population (9.8) of weeds was recorded in weed free check plots where frequent manual hoeing was done to remove weeds at specific intervals, followed by pendimethalin @1.0kg a.i ha^{-1} as Pre em.+quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing (T_4). Higher weed density in Farmer's practice might have been due to emergence of more weeds after the effect of glyphosate application was over as it had little or no residual effects which could inhibit germination of new weeds. All the studied herbicidal treatments reduced weed population over that of weedy check and increased weed control efficiency. Maximum weed dry weight in weedy check might have been due to highest weed density. These observations are in line with Anjum *et al.* (2007). Dry weight of weeds was significantly lower in herbicide treated plots as compared to weedy checks because of the difference in weed population. Application of pyrithiobac sodium @ 62.5g a.i/ha alone or in combination could not express any visible toxic effect on cotton crop, indicating its selectivity, although new chemicals *i.e.*, pyrithiobac sodium and quizalofopethyl could not outperform the existing recommended chemicals for weed management in cotton. Highest weed control efficiency (WCE) was exhibited under weed free check (86.8%) followed by pendimethalin @1.0kg a.i ha^{-1} as Pre em. + quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing (73.7%) and pyrithiobac sodium @ 62.5g a.i ha^{-1} + quizalofopethyl @50g a.i ha^{-1} at 2-4 weed leaf stage + one hoeing (61.7%) whereas minimum values were recorded for weedy check (24.7%). The differences in weed control efficiency among different treatments can be attributed to the differences in

Table 3 : Weed count and dry matter under different weed management treatments

Weed management	Initial weed count m^{-2} (before spray)			Final weed count m^{-2} (after spray)			Initial weed dry matter ($g\ m^{-2}$)			Final weed dry matter ($g\ m^{-2}$)		
	2012	2013	pooled	2012	2013	pooled	2012	2013	pooled	2012	2013	pooled
T_1: Pendimethalin@1.0kg a.i ha^{-1} as Pre emr+one hoeing	49.7	52.3	51.0	44.3	38.3	41.3	33.2	41.1	37.1	189.9	227.1	208.5
	(44.8)	(46.3)	(45.5)	(41.7)	(38.0)	(39.8)	(5.83)	(6.48)	(6.15)	(13.8)	(15.1)	(14.4)
T_2: Trifluralin@1.2kg a.i ha^{-1} PPI + one hoeing	56.7	65.1	60.9	55.7	42.0	48.8	30.1	52.5	41.2	184.0	245.6	214.8
	(48.9)	(54.2)	(51.5)	(48.3)	(40.3)	(44.3)	(5.56)	(7.26)	(6.41)	(13.5)	(15.7)	(14.5)
T_3: Quizalofopethyl@50g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing	61.5	61.4	61.4	37.0	56.0	46.5	40.6	49.8	45.1	162.9	236.6	199.7
	(51.6)	(51.6)	(51.6)	(37.4)	(48.5)	(42.9)	(6.43)	(7.12)	(6.77)	(12.8)	(15.4)	(14.1)
T_4: Pendimethalin@1.0kg a.i ha^{-1} +Quizalofopethyl @50g a.i ha^{-1}+one hoeing	49.2	59.1	54.1	33.0	27.0	30.0	33.7	47.8	40.7	90.6	96.5	93.6
	(44.5)	(50.3)	(47.4)	(34.9)	(31.1)	(33.0)	(5.88)	(6.95)	(6.42)	(9.6)	(9.8)	(9.7)
T_5: Pyrithiobac sodium @ 62.5g a.i ha^{-1} at 2-4 weed leaf stage+one hoeing	49.5	55.5	52.5	33.7	36.0	34.8	37.2	49.8	43.4	210.5	252.6	231.6
	(44.6)	(48.2)	(46.4)	(35.4)	(36.8)	(36.0)	(6.17)	(7.12)	(6.64)	(14.5)	(15.9)	(15.2)
T_6: Pyrithiobac sodium@ 62.5g a.i ha^{-1}+Quizalo-fopethyl@50g a.i ha^{-1} at 2-4 weed leaf stage+ one hoeing	63.0	57.3	60.1	30.0	40.0	35.0	38.7	46.2	42.4	126.2	148.5	137.3
	(52.2)	(49.2)	(50.8)	(33.1)	(39.1)	(36.2)	(6.28)	(6.85)	(6.57)	(11.3)	(12.1)	(11.6)
T_7:Glyphosate@1.0kg a.i ha^{-1} as directed spray at 45 DAS	50.0	60.3	55.1	32.2	44.0	38.1	39.5	48.9	44.2	199.2	275.0	237.1
	(45)	(51.0)	(47.9)	(34.5)	(41.4)	(38.0)	(6.34)	(7.05)	(6.70)	(14.1)	(16.6)	(15.4)
T_8: Weed Free check	54.7	48.3	51.5	6.8	12.7	9.8	35.3	44.5	39.9	20.8	82.3	51.5
	(47.7)	(43.9)	(45.8)	(15.0)	(20.8)	(17.9)	(6.01)	(6.72)	(6.37)	(4.7)	(9.1)	(6.89)
T_9: Farmers practice	52.5	56.5	54.5	65.2	65.5	65.3	40.2	0.1	45.1	248.5	321.3	284.9
	(46.3)	(48.8)	(47.5)	(53.9)	(54.1)	(54.0)	(6.41)	(7.11)	(6.76)	(15.8)	(17.9)	(16.8)
T_{10}:Weedy check/Control	47.7	55.3	51.5	71.5	84.5	78.0	41.1	48.4	44.7	307.1	418.6	362.8
	(43.6)	(48.0)	(45.8)	(58.3)	(67.3)	(62.7)	(6.48)	(7.01)	(6.74)	(17.5)	(20.4)	(18.9)
LSD (0.05)	**NS**	**NS**	**NS**	**10.8**	**13.1**	**5.11**	**NS**	**NS**	**NS**	**37.4**	59.0	**34.2**

Data for weed count and dry matter has been subjected to arcsine and square root transformation, respectively. Figures in parenthesis are means of transformed values

mortality of weeds owing to variable efficacy of the tested herbicides. The results are supported by the findings of Sandangi and Barik (2007) and Nadeem *et al.* (2013) who also reported significant differences in weed control efficiency with different weed control treatments. Relatively higher values for weed count as well as dry matter could be attributed to higher rainfall (870.1mm) during 2013 as compared to 2012 (223.6mm). Anjum *et al.* (2007) has also reported similar variation for weed indices owing to rainfall differences in the studied years.

Pooled data indicated significant differences in various studied monetary parameters. The cost of cultivation was highest for weed free check (₹ 48084 ha^{-1}) owing to labour intensive weeding operations required to keep it weed free over the season besides more picking charges owing to enhanced yield. Statistically, least cost of cultivation (₹28864 ha^{-1}) was recorded in weedy check. However, gross (₹142745 ha^{-1}) as well as net returns (₹94660 ha^{-1}) were highest for weed free check though at par with T_4 *i.e.*, pendimethalin @1.0kg a.i ha^{-1} as Pre em. +quizalofopethyl @50g a.i/ha at 2-4 weed leaf stage + one hoeing but significantly better than the rest of the treatments. Highest B:C ratio was recorded in case of T_4 (2:11) while significantly least value (1.0) was recorded under weedy check. Today, human labour is least available as and when required besides being uneconomic as also depicted by comparatively reduced B:C values under weed free check. Therefore for efficient weed management in cotton, combination of cultural and chemical methods is the practical solution. Based on the present findings, it is concluded that application of pendimethalin + quizalofopethyl + one hoeing has proved beneficial for realizing better seed cotton yield under semi arid agro ecosystems.

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