RESEARCH ARTICLE

COMPARATIVE STUDY OF MIXED WEED FLORA IN WHEAT WITH APPLICATION OF HERBICIDES AND ITS RESIDUAL EFFECT ON THE MUNGBEAN CROPS

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Abstract: The field experiment conducted at research farm, RARI, Durgapura for two consecutive years during *rabi* seasons 2013-14 and 2014-15. Results of revealed that highest weed control efficiencies of 89.4 per cent were recorded with hand weeding at harvest stage. It was closely followed by sulfosulfuran @ 25 gm a.i. /ha, clodinafop-propargyl 15 % + metsulfuran methyl 1 % @ 64 g a.i. /ha, sulfosulfuran 75 % + metsulfuran methyl 5 WG @ 32 g a.i. /ha, carfentrazone Ethyl 40 % DF @ 20 g a.i./ha, metsulfuran methyl @ 4 g a.i. / ha, 2,4-D ester @ 0.5 kg/ha and pendimethalin pre emergence treatments. N, P and K in grain and straw of wheat were significantly improved due to most of the weed control treatments over weedy check. Weed free, clodinafop propargyl 15 % + metsulfuran methyl 1 % @ 64 g a.i. /ha, sulfosulfuran 75 % + metsulfuran methyl 5 WG @ 32 g a.i. /ha and hand weeding were the superior treatments in this regarded. Further, none of the applied herbicides/mixtures in *rabi* season (wheat) had residual toxicity on effective nodules and total branches per plant of moongbean crop grown in *kharif* season.

Keywords: Herbicide mixture, Weed control efficiencies, Nutrient concentration, Effective nodule, Mungbean crop

INTRODUCTION

Wheat is an important winter cereal contributing about 38% of the total food grain production in India. In India wheat production increased from 23.83 MT (1970-71) to 95.85 MT in the year 2013-14. This is attributed mainly to increase in productivity from 13.07 to 31.45 q/ha and acreage from 18.24 to 30.47 million hectare (Anonymous, 2015). Likewise, in Rajasthan the wheat production increased from 1.98 MT to 9.78 MT with acreage from 1.48 M ha to 3.08 M ha during 2013-14 as compared to year 1970-71 (Anonymous, 2015a). In spite of spectacular growth in productivity, the yield per unit area remains far below the potential of improved varieties. Among the various factors limiting productivity, weeds take heavy toll because of adequate nutrients and moisture supplied to the crops. Wheat crop is invaded by a large number of fast growing weeds species. It is infested with both grassy and broadleaf weeds. The losses caused by weeds have been estimated to be much higher than those caused by insects, pests and diseases together (Fakkar and Amin, 2012). Weeds germinate even before its germination and flourish more and more taking the advantage of its slow initial growth. Competition from weeds throughout the crop season reduces yield by 10 to 38 % depending upon time and intensity of weed infestation. So, there is an urgent need to evolve appropriate weed management strategy for both grassy and broadleaf weeds for exploiting the yield potential of this crop.

MATERIALS AND METHODS

The field experiment conducted at research farm, RARI, Durgapura for two consecutive years during *rabi* seasons 2013-14 and 2014-15 on loamy sand soil. The experiment comprised of eleven weed control treatments i.e. Weedy check (T_1), Hand weeding at 30-35 DAS (T_2), 2,4-D ester @ 0.5 kg/ha at 30-35 DAS (T_3), Sulfosulfuron @ 25 g ai. at 30-35 DAS (T_4), Metsulfuron methyl @ 4 g/ha at 30-35 DAS (T_5), Sulfosulfuron 75% + Metsulfuron methyl 5% WG @ 32g at 30-35 DAS (T_6), Piroxofop-propargyl 15% WP @ 60g ai./ha 30-35 DAS (T_7), Clodinafop-propargyl15% + Metsulfuron methyl 1% @ 64g ai./ha at 30-35 DAS (T_8), Carfentrazone ethyl @15 g/ha at 30-35 DAS (T_9), Pendimethalin pre emergence (T_{10}) and Weed free (T_{11}) were laid out in Randomized block design and replicated four times. In order to evaluate the weed control treatments for their efficacy, weed control efficiency of each treatment at harvest stage was calculated by using the following formula. The formula was suggested by Umrani and Boi, 1982.

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

Where, X = Weed dry matter in weedy check plot
and Y = Weed dry matter in treated plot

Nutrient concentration in wheat (%) the representative samples of seed and stover drawn at the time of threshing and winnowing were ground and analysed for nitrogen, phosphorus and potassium concentration. Nitrogen concentration in seed and straw representative samples of wheat grain and straw taken at harvest were oven dried, ground in Willey mill and analysed for their nitrogen

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concentration. Nitrogen was estimated by colorimetric method (Snell and Snell, 1949). Plant samples were digested with sulphuric acid and treated with hydrogen peroxide to remove black colour. Nesseler's reagent was used to develop the colour. The results so obtained were expressed as per cent nitrogen concentration. Phosphorus concentration in seed and straw the samples of wheat grain and straw were also subjected to chemical analysis for their phosphorus concentration. These samples after grinding were digested in tri acid mixture and P was estimated by 'vanadomolybdophosphate' yellow colour method in nitric acid system (Jackson, 1957). Effective nodules per plant of moongbean for counting the numbers of root nodules per plant at 40 DAS, three plants in each plot were randomly selected in sampling rows and removed them carefully after wetting the soil and taking the soil upto 30 cm depth. The plants were removed with soil from the plot and the adhered soil was washed out with a fine jet of water. The nodules were removed with the help of forcep, counted and the mean of three plant nodules was recorded as total number of nodules per plant. Out of the total nodules, effective nodules were separated out and the average number of effective nodules/plant recorded.

RESULTS AND DISCUSSION

Effect of different weed control practices on weed control efficiency

It is obvious from the data presented in Table 1 that different weed control treatments differed slightly in their efficiencies to control the weeds. Hand weeding found comparatively better in this respect. Two years mean data showed that the highest weed control efficiency (89.4 per cent) was recorded at harvest stage with hand weeding and sulfosulfuran @ 25 g *a.i.*/ha (89.4 per cent) than weedy check and emerged as the most effective herbicidal. These were closely followed by clodinafop propargyl 15 % + metsulfuran methyl 1 % @ 64 g a.i./ha, sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g a.i./ha, carfentrazone Ethyl 40 % DF @ 20 g *a.i.*/ha ,metsulfuran Methyl @ 4 g *a.i.*/ ha, 2,4-D ester @ 0.5 kg/ha and pendimethalin pre emergence. These treatments reduced the weed biomass by 89.1, 89.0, 88.9, 87.6, 87.4 and 87.2 per cent at harvest stage, respectively. The variation in weed control efficiency is directly associated with the amount of weed biomass accumulated under different treatments. Hand weeding removed initial flushes of weeds. It seems to be the most spectacular reason of wide variation in weed control efficiency. Almost similar results were obtained by Kurchania *et al*. (2000) and Bhatia *et al*. (2012) in wheat grown in different agro climatic conditions. The results also corroborate to the findings of Khokhar and Nepalia (2010) in wheat.

Effect of different weed control practices on nutrient concentration

Different weed control treatments differed widely in influencing N concentration in grain and straw of wheat (Table 2). Data showed that all the treatments except piroxofop-propargyl recorded significantly higher concentration of N in grain and straw over weedy check during both the years. The maximum pooled N concentration in grain was observed in weed free treatment (1.79%) that was closely accompanied by hand weeding (1.78%), clodinafop propargyl 15 % +metsulfuran methyl 1 % @ 64 g *a.i.*/ha (1.77%) and sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g *a.i.*/ha (1.76%). These four treatments also registered 0.096, 0.091, 0.088 and 0.085 per cent more N concentration in straw than weedy check. However, the difference in N concentration in grain and straw among these four treatments was not upto the level of significance. The extent of increase in N concentration due to carfentrazone ethyl 40 % DF @ 20 g *a.i.*/ha , metsulfuran methyl @ 4 g *a.i.*/ ha , 2,4-D ester @ 0.5 kg/ha , sulfosulfuran @ 25 gm*a.i.*/ha , pendimethalin pre emergence and piroxofop-propargyl 15 % WP 60 g *a.i.*/ha was 22.1, 21.1, 14.7, 13.6, 12.9 and 5.2 per cent in grain and 28.9, 23.6, 20.8, 19.9, 18.9 and 3.3 per cent in straw than weedy check.Higher concentration of nutrients in crop can be ascribed mainly to the greater availability of nutrients under reduced crop-weed competition under different weed control treatments as per their efficiency that would otherwise have been utilized by fast growing weeds under infested conditions.Such findings have also been reported by Kanojia and Nepalia (2006) in wheat, Singh *et al*. (2009) in barley and Khokhar and Nepalia (2010) in wheat.

A critical examination of the data presented in table 3 indicated that all the weed control treatments except piroxofop-propargyl 15% WP significantly enhanced the P concentration in grain and straw of wheat over weedy check. On pooled basis the maximum concentration in grain was observed in carfentrazone (0.436%) closely followed by weed free (0.435%), hand weeding (0.427%), clodinafoppropargyl 15 % + metsulfuran methyl 1 % @ 64 g *a.i.*/ha (0.425%) and sulfosulfuran 75 % + metsulfuran methyl 5% WG @ 32 g *a.i.*/ha (0.419%). However, the difference in P concentration among these four treatments was not of statistical significance. Being at par among themselves, these four treatments also witnessed 26.8, 25.0, 24.1 and 23.1 per cent higher P concentration in wheat straw. The extent of increase in P concentration due to carfentrazone ethyl 40 % DF @ 20 g *a.i.* /ha, metsulfuran methyl @ 4 g *a.i.*/ ha, 2,4-D ester @ 0.5 kg/ha, sulfosulfuran @ 25 gm *a.i.*/ha, pendimethalin pre emergence and piroxofop-propargyl 15 % WP 60 g *a.i.*/ha was 24.9, 19.2, 12.1, 11.2, 10.1 and 5.4 per cent in grain and 16.7, 14.8, 12.1, 11.2, 10.2 and 4.6 per cent in straw than weedy check.

Residual effect of different weed control practices on succeeding crops

Total branches and effective nodules of moongbean: It is clear from the pooled data of two years (Table 4)showed that maximum total branches per plant (14.1) was reported for weedy check followed by piroxofop-propargyl 15 % WP 60 g *a.i.*/ha (14.0),sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g *a.i.*/ha (13.9) and pendimethalin pre emergence (13.9). While, the minimum total branches per plant was depicted by weed free (12.5). It is obvious from the pooled data of two years (Table 4) showed that highest effective nodules per plant (32.9) was reported for weed free followed by hand weeding (32.5), metsulfuran methyl @ 4 g a.i./ ha (32.3) and sulfosulfuran @ 25 gm *a.i.*/ha (32.1). However, the lowest effective nodules per plant was manifested by weedy check (30.5).These results are in line with those of Yadav *et al*. (2003), Singh and Ali (2004), Chopra and Chopra (2005), Vala (2005) and Singh *et al*, (2012).

Table 1. Effect of weed control treatments on weed control efficiency at harvest

Treatments	Weed control efficiency (%)		
	2014	2015	Pooled
Weedy check	0.0	0.0	0.0
Hand weeding at 30 – 35 DAS	89.4	89.4	89.4
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	87.4	87.3	87.4
Sulfosulfuran @ 25 gm a.i./ha at 30 – 35 DAS	89.3	89.4	89.4
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	87.6	87.7	87.6
Sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	89.1	88.9	89.0
Piroxofop-Propargyl 15 % WP 60 g a.i. /ha at 30 – 35 DAS	87.0	86.9	86.9
Clodinafoppropargyl 15 % +metsulfuran methyl 1 % @ 64 g a.i. /ha at 30 – 35 DAS	89.2	88.9	89.1
Carfentrazone Ethyl 40 % DF @ 20 g a.i./ha at 30 – 35 DAS	88.9	88.9	88.9
Pendimethalin pre emergence	87.2	87.2	87.2
Weed free	100.0	100.0	100.0
SEm+	2.52	2.33	1.63
CD (P=0.05)	7.27	6.72	4.61

Table 2. Effect of weed control treatments on N content in grain and straw

Treatments	N content (%)					
	Grain			Straw		
	2014	2015	Pooled	2014	2015	Pooled
Weedy check	1.381	1.391	1.386	0.210	0.212	0.211
Hand weeding at 30 – 35 DAS	1.769	1.795	1.782	0.295	0.309	0.302
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	1.588	1.591	1.590	0.252	0.258	0.255
Sulfosulfuran @ 25 gm a.i./ha at 30 – 35 DAS	1.561	1.588	1.575	0.250	0.256	0.253
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	1.666	1.691	1.679	0.258	0.263	0.261
Sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	1.755	1.777	1.766	0.290	0.301	0.296
Piroxofop-Propargyl 15 % WP 60 g a.i. /ha at 30 – 35 DAS	1.451	1.466	1.459	0.214	0.222	0.218
Clodinafoppropargyl 15 % +metsulfuran methyl 1 % @ 64 g a.i. /ha at 30 – 35 DAS	1.761	1.786	1.774	0.292	0.305	0.299
Carfentrazone Ethyl 40 % DF @ 20 g a.i./ha at 30 – 35 DAS	1.685	1.700	1.693	0.270	0.273	0.272
Pendimethalin pre emergence	1.549	1.582	1.566	0.248	0.254	0.251

Weed free	1.782	1.810	1.796	0.302	0.312	0.307
SEm±	0.057	0.065	0.044	0.013	0.014	0.010
CD (P=0.05)	0.166	0.189	0.123	0.037	0.041	0.027

Table 3. Effect of weed control treatments on P content in grain and straw

Treatments	P content (%)					
	Grain			Straw		
	2014	2015	Pooled	2014	2015	Pooled
Weedy check	0.347	0.351	0.349	0.106	0.109	0.108
Hand weeding at 30 – 35 DAS	0.417	0.420	0.419	0.134	0.136	0.135
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	0.382	0.399	0.391	0.120	0.122	0.121
Sulfosulfuran @ 25 gm a.i./ha at 30 – 35 DAS	0.381	0.395	0.388	0.118	0.121	0.120
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	0.412	0.420	0.416	0.122	0.126	0.124
Sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	0.410	0.440	0.425	0.132	0.133	0.133
Piroxofop-Propargyl 15 % WP 60 g a.i. /ha at 30 – 35 DAS	0.364	0.371	0.368	0.109	0.117	0.113
Clodinafoppropargyl15 % +metsulfuran methyl 1 % @ 64 g a.i. /ha at 30 – 35 DAS	0.414	0.440	0.427	0.133	0.135	0.134
Carfentrazone Ethyl 40 % DF @ 20 g a.i./ha at 30 – 35 DAS	0.422	0.450	0.436	0.124	0.128	0.126
Pendimethalin pre emergence	0.377	0.391	0.384	0.117	0.120	0.119
Weed free	0.419	0.450	0.435	0.135	0.138	0.137
SEm±	0.010	0.013	0.008	0.003	0.004	0.002
CD (P=0.05)	0.029	0.038	0.024	0.009	0.011	0.007

Table 4. Residual effect of weed control treatments on total branches per plant and effective nodules per plant of mungbean

Treatments	Total branches per plant			Effective nodules per plant		
	2014	2015	Mean	2014	2015	Mean
Weedy check	14.1	14.1	14.1	30.1	30.8	30.5
Hand weeding at 30 – 35 DAS	13.6	13.6	13.6	32.5	32.6	32.5
2,4-D ester @ 0.5 kg/ha at 30 – 35 DAS	13.6	12.6	13.1	28.6	30.6	29.6
Sulfosulfuran @ 25 gm a.i./ha at 30 – 35 DAS	13.3	13.2	13.2	32.1	32.2	32.1
Metsulfuran Methyl @ 4 g a.i. / ha at 30 – 35 DAS	13.5	13.6	13.6	32.3	32.3	32.3
Sulfosulfuran 75 % +metsulfuran methyl 5% WG @ 32 g a.i. /ha at 30 – 35 DAS	13.9	13.9	13.9	31.9	31.9	31.9
Piroxofop-Propargyl 15 % WP 60 g a.i. /ha at 30 – 35 DAS	14.0	14.0	14.0	30.9	31.0	31.0
Clodinafoppropargyl 15 % +metsulfuran methyl 1 % @ 64 g a.i. /ha at 30 – 35 DAS	13.1	13.2	13.1	31.0	31.1	31.0
Carfentrazone Ethyl 40 % DF @ 20 g a.i./ha at 30 – 35 DAS	13.2	13.2	13.2	31.4	31.4	31.4
Pendimethalin pre emergence	13.9	13.9	13.9	30.9	31.9	31.4
Weed free	12.7	12.3	12.5	32.9	32.9	32.9

CONCLUSION

Based on the results of two years experimentation, it is concluded that conventional method of hand weeding is the most effective and remunerative weed control measure in wheat. Amongst herbicides, clodinafop propargyl 15 % + metsulfuran methyl 1 % @ 64 g a.i /ha or sulfosulfuran 75 % + metsulfuran methyl 5 WG @ 32 g a.i./ha found best option for weed control in wheat under especially in labour scarce regions. Further, none of the applied herbicides/mixtures applied in *rabi* season (wheat) had residual toxicity on predominant crops (pearlmillet, mungbean and clusterbean) grown in *kharif* season.

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