Journal of Crop and Weed, 12(3):163-167(2016)

Chemical weed management in black gram (*Vigna mungo* L.)

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Received : 20.12.2016 ; Revised : 28.12.2016 ; Accepted : 30.12.2016

ABSTRACT

Field experiments were conducted for three years at Pulses and Oilseeds Research Station, Berhampore, Murshidabad, West Bengal, India during kharif 2010, 2011 and 2012 to develop an efficient chemical weed management practice with newer herbicidal molecules in black gram. The experiment was laid out in a randomized block design with three replications having nine treatments viz. W_0 – Weedy check, W_1 – Hand weeding twice at 20 and 40 DAS, W_2 – Pendimethalin @ 1.0kg ha^{-1} as PE (Pre-emergence) at 1 DAS, W_3 – Quizalofop ethyl @ 37.5g ha^{-1} as PoE (Post-emergence) at 10-15 DAS, W_4 – Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS), W_5 – Fenoxaprop-p-ethyl @ 50g ha^{-1} as PoE (10-15 DAS), W_6 – Quizalofop ethyl @ 37.5g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) , W_7 – Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) , and W_8 – Imazethapyr @ 25ml ha^{-1} as PoE (15-20 DAS). Experimental results revealed that highest seed yield (1266.5 kg ha^{-1}) was recorded under the treatment W_1 and lowest with W_0 (622.2 kg ha^{-1}). Application of chemical herbicides significantly improved the seed yield over $W_{0.}$ The treatments W_7 (1247.4 kg ha^{-1}) and W_6 (1195.1 kg ha^{-1}) were found at par with $W_{1.}$ Significant reduction in the total weed density and total weed dry weight were found with the application of Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) and Quizalofop ethyl @ 37.5g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS). Chemical weed control measures increased the total microbial population by 80.3 to 109.5% over weedy check and 57.5 to 83% over twice hand weeding. It was also revealed that nodulation in black gram was not affected significantly due to the application of chemical herbicides.

Keywords : Black gram, chemical weed management, microbial population, nodulation, seed yield, weed control efficiency

With the growing population of the world in general and the developing countries in particular, demands are overwhelmed for enhanced food production. Besides emphasizing on main crops and vegetables, various pulses also play an important role to satisfy the growing human food demands. Among many others, black gram is an important pulse crop and a source of food for the people especially in the subcontinent. In India pulses are mostly grown by the small and marginal farmers under resource constraints situation. In India black gram is mostly grown by the farmers during *kharif* (June/ July – September/October) season. About 70 per cent of World's black gram production comes from India. In India black gram is grown in an area of 27.3 lakh ha. with a production of 11.81 lakh tonnes. In the state of West Bengal *kharif* black gram is grown under medium land situation, in 52.5 thousand ha. area with a production of 31.2 thousand tonnes. About 60 per cent of pulse area in West Bengal is covered by lentil and black gram and rest by other pulse crops. It is mostly grown by the farmers after harvesting of summer rice, wheat, potato or early jute. During *kharif* season the problem of weed emergence is most predominant and thus crop faces maximum competition during this part of the year which ultimately reduces the yield to a considerable extent. The crop is not a very good competitor against weeds (Choudhary *et al*., 2012) and therefore, weed-control initiatives are essential to ensure proper crop growth, particularly in the early growth period. Depending on the nature, density and period of occurrence, weeds can cause losses of seed yield of blackgram varying from 41.6 to 64.1 per cent (Chand *et al*., 2004 and Singh, 2011). Since hand weeding and other weed control methods are laborious, time consuming, costly and difficult, chemicals are the obvious and cost effective methods of weed control. For this many pre-emergence herbicides were released and used by the farmers but very few post-emergence herbicides are available. The chemical weed control method is becoming popular among the farmers as they continue to realize the usefulness of herbicides.

Therefore, the present experiment was initiated with the objective to develop a suitable and effective chemical weed management practice for *kharif* black gram.

MATERIALS AND METHODS

Field experiments were conducted at Pulses and Oilseeds Research Station, Berhampore, Murshidabad, West Bengal, India situated at $24^0 60'$N latitude, $88^0 15'$ E longitude at an elevation of 19.0 meters above the mean sea level (MSL) during *kharif* 2009, 2010 and 2011. Initial soil samples were collected randomly from different locations of the experimental area with the

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help of auger from 0-15 cm. soil depth. Those were then thoroughly mixed, dried in shade and sieved and the volume of soil samples to be analyzed were there after reduced using partitioning method. Those soil samples were then kept in polythene bags for mechanical and chemical analysis. The soil of the experimental field was sandy loam in texture and slightly alkaline in reaction (pH 7.5) having an organic carbon content of 0.31 per cent, 72 kg available P ha^{-1} and 110 kg available K ha^{-1}. The experiment was laid out in a randomized block design with three replications having nine treatments *viz.* W_0 – Weedy check, W_1 – Hand weeding twice at 20 and 40 DAS, W_2 – Pendimethalin @ 1.0 kg ha^{-1} as PE (Pre-emergence) at 1 DAS, W_3 – Quizalofop ethyl @ 37.5g ha^{-1} as PoE (Post-emergence) at 10-15 DAS, W_4 – Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS), W_5 – Fenoxaprop-p-ethyl @ 50g ha^{-1} as PoE (10-15 DAS), W_6 – Quizalofop ethyl @ 37.5g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) , W_7 – Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) , and W_8 – Imazethapyr @ 25ml ha^{-1} as PoE (15-20 DAS)with a plot size of 4 x 3 m. The black gram variety used was Sarada (WBU-108) and the seed rate was 30 kg ha^{-1}. with a spacing of 30 x 10 cm. The fertilizer applied was 20-40- 40 kg N-P-K ha^{-1} applied as basal in the form of urea, single super phosphate and muriate of potash. The herbicides were sprayed by using hand operated knapsack sprayer fitted with herbicide nozzle of ASPEE ULV 100. The spray volume used was 400L ha^{-1}. Density of weeds *viz.*, grasses, sedges and broad leaf weeds were recorded species wise in a fixed square meter area at pre treatment, 15, 30 and 45 DAS. Dry weight of weeds were recorded from 0.25 m^2 destructive sampling area. Weed control efficiency was also calculated as suggested by Maity and Mukherjee (2011). For microbial population study, soil samples were collected from each treatment and from this representative soil sample of each treatment, 1g of field soil was measured by precision balance and then it was diluted up to 10^6 times by following serial dilution method as done by Elad *et al*. (1980), Baker (1968) and Naher (2013). Then this diluted soil was spreaded into the media plates to develop microbial colony. To enumerate total bacterial, fungal and actinomycetes population nutrient agar (NA), potato dextrose agar (PDA) amended with 30ppm rose bengal and actinomycetes media plates were used, respectively. The number of CFU (Colony Forming Units) were counted 1DA (Day After) 3DA and 6DA by keeping the plates in incubator at 25-30ºC as done by Elad *et al.*(1980), Baker (1968) and Naher (2013). The microbial population was expressed in terms of C.F.U. / g of soil. Nodulation was studied at 15 days interval starting from 15 DAS up to 45 DAS. Only active nodules were considered. The nodules with the pink colour of leg haemoglobin were considered active nodules. Nodules were dried in a hot air oven at 75°C and their dry weights were recorded in a sensitive balance to get the dry weight of nodule per plant.

Data on seed yield (kg ha^{-1}) were recorded at harvest. Analysis of variance of the data in the experimental design and comparison of means at pd" 0.05 were carried out, using MSTAT-C software.

RESULTS AND DISCUSSION

Effect on seed yield

Experimental results revealed that weed management practices significantly influenced the seed yield of black gram variety Sarada (WBU-108) (Table 1). Based on the pooled value of three years, it was observed that the highest seed yield (1266.5 kg ha^{-1}) was recorded under the treatment W_1 (Twice hand weeding), might be due to adequate weed control during the cropping period, which provided maximum moisture and nutrients for healthy plant growth (Sultana *et al*., 2009) and lowest seed yield was recorded with weedy check (W_0) (622.2 kg ha^{-1}) which was mainly due to heavy infestation of weeds. Application of chemical herbicides significantly improved the seed yield over $W_{0.}$ Application of Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) recorded highest seed yield of black gram (1247.4 kg ha^{-1}) among the chemical weed control measures, which was found *at par* with W_6 (1195.1 kg ha^{-1}) *i.e.* application of Quizalofop ethyl @ 37.5g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) and twice hand weeding (W_1). These were closely followed by application of Imazethapyr @ 25ml ha^{-1} as PoE (15-20 DAS) *i.e.* W_8 which recorded a seed yield of 1148.9 kg ha^{-1}.The increase in grain yield was mainly attributed to better weed control efficiency by reducing the weed density and weed dry weight. These results corroborated with the findings of Das *et al.* (2014), Asaduzzaman *et al.* (2010) and Mundra and Maliwal (2012).

Effect on weed flora

The experimental field was dominated by natural infestation of broad leaf weed (BLW) like *Ageratum conyzoides*, *Borreria hispida*, *Commelina benghalensis* and grasses like *Echinochloa colona*, *Cynodon*

Table 1 : Effect of different weed management practices on seed yield (kg ha^{-1}) of black gram (pooled data of three years).

Treatment	2009	2010	2011	Mean
W_0 – Weedy check	619.00	618.0	629.7	622.2
W_1 – Hand weeding twice at 20 and 40 DAS	1261.67	1263.0	1274.7	1266.5
W_2 – Pendimethalin @ 1.0kg ha^{-1} as PE (Pre-emergence) at 1 DAS	1130.00	1118.3	1133.0	1127.1
W_3 – Quizalofop ethyl @ 37.5g ha^{-1} as PoE (Post-emergence) at 10-15 DAS	933.33	927.0	938.0	932.8
W_4 – Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS)	843.33	839.0	855.0	845.8
W_5 – Fenoxaprop-p-ethyl @ 50g ha^{-1} as PoE (10-15 DAS)	1046.67	1043.3	1054.3	1048.1
W_6 – Quizalofop ethyl @ 37.5g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS)	1195.00	1193.0	1197.3	1195.1
W_7 – Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS)	1240.00	1245.3	1257.0	1247.4
W_8 – Imazethapyr @ 25ml ha^{-1} as PoE (15-20 DAS)	1143.33	1140.3	1163.0	1148.9
SEm (±)	**30.41**	**33.41**	**33.92**	**32.4**
LSD (P=0.05)	**91.16**	**100.15**	**100.86**	**97.1**

Table 2: Effect of different weed management practices on weed density, weed dry weight, weed control efficiency, total microbial population and nodulation of black gram (pooled data of three years)

Treatment	Weed density (Nos.m^{-2}) 45 DAS	Weed dry weight (gm^{-2}) 45 DAS	Weed control efficiency (%)	Microbial population (CFU×10^6 g^{-1} of soil) at harvest	No. of nodules per plant (45 DAS)	Nodule dry weight (mg plant^{-1}) (45 DAS)
W_0 – Weedy check	461.5	70.5	0.0	32.5	13.45	74.5
W_1 – Hand weeding twice at 20 and 40 DAS	52.2	10.6	84.9	37.2	18.07	121.5
W_2 – Pendimethalin @ 1.0kg ha^{-1} as PE (Pre-emergence) at 1 DAS	148.6	24.6	65.1	58.6	16.30	97.3
W_3 – Quizalofop ethyl @ 37.5g ha^{-1} as PoE (Post-emergence) at 10-15 DAS	168.3	26.3	62.7	65.5	17.10	115.5
W_4 – Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS)	185.3	28.8	59.1	60.2	16.55	102.3
W_5 – Fenoxaprop-p-ethyl @ 50g ha^{-1} as PoE (10-15 DAS)	155.6	25.1	64.3	68.8	17.21	119.3
W_6 – Quizalofop ethyl @ 37.5g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS)	95.5	19.9	71.8	63.0	16.67	107.6
W_7 – Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS)	88.9	19.0	73.0	68.1	17.05	112.6
W_8 – Imazethapyr @ 25ml ha^{-1} as PoE (15-20 DAS)	106.8	20.6	70.8	61.5	16.50	99.8
SEm(±)	**9.4**	**0.8**	**-**	**5.5**	**0.7**	**8.2**
LSD (P=0.05)	**28.8**	**2.3**	**-**	**16.8**	**2.1**	**24.0**

dactylon, *Paspalum scrobiculatum*, *Digitaria sanguinalis* and sedges like *Cyperus rotundus*. The maximum weed density and weed dry weight (70.5 gm^{-2}) was recorded in weedy check followed by Chlorimuron ethyl @ 4.0g ha^{-1} as PoE at 10-15 DAS (28.8 gm^{-2}) are given in table 2. The lowest weed density(52.2 nos.m^{-2}) and weed dry weight (10.6 gm^{-2}) was recorded in hand weeding twice followed by application of Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE at 10-15 DAS (19.0 gm^{-2}) (Table 2). Weed dry weight reflects the growth potential of the weeds and is a better indicator of its competitive ability with the crop plants. Un-weeded check recorded the highest weed growth and weed biomass. In general, combined application of herbicides were found to be superior to individual application of herbicides because combined application can control a broad spectrum of weeds and thus provide a better weed control efficiency. Weed control efficiency of hand weeding twice and application of Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) were 84.9 per cent, 73.0 per cent respectively over weedy check as hand weeding at 20 DAS (days after sowing) effectively prevent or control early emerged weeds followed by hand weeding at 40 DAS control the later emerged weeds (Yadav *et al*., 2004).

Effect on total soil microbial population

Total microbial population was significantly influenced by weed management practices. Highest microbial population (68.8×10^{6} g^{-1} of soil) at harvest was recorded with application of Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) and lowest with weedy check (32.5×10^{6} g^{-1} of soil). The result was in conformity with the findings reported by Ali *et al.* (2014). Twice hand weeding recorded significantly lower microbial population (37.2×10^{6} g^{-1} of soil) than chemical weed control measures as also reported by Sapundjieva *et al.* (2008). Chemical weed control measures increased the total microbial population by 80.3 to 109.5 per cent over weedy check and 57.5 to 83 per cent over twice hand weeding which might be due to the fact that initially total microbial population did not vary significantly in all the treatments but after herbicide application; they differ for a short period of time. Having the ability to degrade herbicides, microorganisms utilize them as a source of biogenic elements for their own physiological processes. As herbicides have toxic effects on microorganisms; they reduce their abundance, activity and consequently, the diversity of their communities before degradation. Immediately after application, the toxicity of herbicides is normally most severe as their concentration in soil is highest but with the advancement of time, microorganisms degraded the herbicides and their concentration gradually reduced up to half-life. After that, carbon released from degraded herbicide leads to an increase of the soil microflora population (Bera and Ghosh, 2013). Chemical herbicides generally stimulated and increased the soil fungi and actinomycetes population and reduced the bacterial population to some extent and thus increased the overall total microbial population as also reported by Ali *et al.* (2014), Adil *et al.*(2012) and Anderson *et al.*(2004).

Effect on nodulation

Experimental results revealed that nodulation in black gram was not affected significantly due to the application of chemical herbicides. This was in conformity with the findings of Raman and Krishnamoorthy (2005). Highest nodule number (18.07 plant^{-1}) and nodule dry weight(121.5 mg plant^{-1}) were recorded with the treatment twice hand weeding which was found statistically *at par* with the application of chemical herbicides. The lowest nodule number (13.45 plant^{-1}) and nodule dry weight (74.5 mg plant^{-1}) were recorded with the treatment weedy check which was significantly lower than all other treatments might be due to poor growth of the plant itself. The lack of inhibitory effect of herbicides on nodulation obtained could be due to their rapid inactivation in soil or its rapid translocation along with photosynthate, to distant metabolic sink. Similar type of findings were also reported by Ali *et al*.(2014) and Fernandez *et al*. (1992). Applied herbicides were found to have no negative effects on nodule biomass.

Thus, based on 4 years' data it can be concluded that, application of Fenoxaprop-p-ethyl @ 50g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) may be a suitable and effective chemical weed management practice for *kharif* black gram followed by application of Quizalofop ethyl @ 37.5g ha^{-1} + Chlorimuron ethyl @ 4.0g ha^{-1} as PoE (10-15 DAS) .

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