Indian Journal of Agronomy **64** (3): 418–421 (September 2019)

Research Communication

Effect of fertility levels and weed-management practices on weed-control efficiency, yield and nutrients uptake in summer mung bean (*Vigna radiata*)

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Received : November 2018; Revised accepted : September 2019

ABSTRACT

A field experiment was conducted in a split-plot design during the summer season (*zaid*) of 2016 at the Norman Borlaug Crop Research Centre, Pantnagar, Uttarakhand, to evaluate the influence of various fertility levels and weed-management practices on weeds, crop yield and nutrients uptake in summer mung bean [*Vigna radiata* (L.) R. Wilczek]. All fertilizer treatments showed significant effect on grain yield, while weed-control treatments significantly reduced the weed growth and nutrient removal by weeds compared with the weedy check. Among the fertilizer treatments, an application of 18 kg N + 48 kg P_2O_5 + 24 kg K_2O/ha (recommended dose of fertilizer) along with micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) as foliar spray at 20 and 40 days after sowing (DAS) resulted in significantly higher grain yield (853 kg/ha) than rest of the treatments. However, pre-emergence application of pendimethalin (1 kg/ha) followed by 1 hand-weeding (HW) at 30 DAS significantly reduced the weed density and weed dry-matter, with highest weed-control efficiency (63.4%). This combination resulted in the highest grain yield (1,064 kg/ha) with 147% increase over the weedy check and the lowest nutrient removal by weeds, and thus proved to be the best weed-control option in summer mungbean.

Key words **:** Ammonium molybdate, Pendimethalin, Summer mung bean, Weed-control efficiency

Mung bean is one of the important pulse crops in India. India is the biggest producer of mung bean with about 3.83 million ha area under cultivation with production of 1.60 million tonnes (MAFW, GoI, 2016). In intensive cropping system, soil becomes deficient in multi-nutrients and weed infestation, if not controlled causes further yield loss in summer mung bean. Balanced fertilization and effective weed management may help in realizing higher grain yield. Basal application of recommended dose of fertilizer (RDF) often remains insufficient under intensive cropping and the crop may face nutrient deficiency, especially at the later stages under blanket nutrient application. The mid-term correction through foliar nutrition may prove beneficial in this regards. Foliar application of nitrogen at particular crop stage may solve the nutritional problems in pulses when blanket application remains insufficient (Latha and Nadanasababady, 2003). Among the micronutrients, zinc is important for the synthesis of tryptophan as a component of some proteins and a compound needed for the production of growth hormones. Deficiency symptoms of zinc cause characteristic rosetting or clustering of small leaves at the top of the plant (Hafeez *et al.,* 2013). Boron is mainly essential for reproduction of plant and germination of pollen grains. Molybdenum is essential for symbiotic nitrogen fixing bacteria in pulses to fix atmospheric nitrogen. Similarly, weed is an important biotic factor responsible for yield reduction of summer mung bean. Weeds cause 30–50% yield loss in mung bean (Kumar *et al*., 2004). Since, summer mung bean is sensitive to weed competition at early stage of crop growth, weed control is essential for mung bean cultivation at early stage and later on smothering effect on weeds.

The present field experiment was conducted during the summer season of 2016 at the Norman E Borlaug Crop Research Centre (NEBCRC), Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The field was well-drained and properly levelled. The soil experimental field was sandy loam, high in organic carbon (0.86%) and available N (322 kg/ha), medium P_2O_5 (28 kg/ha) and K_2O (220 kg/ha), having *p*H

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(7.2). The experiment was conducted in a split-plot design with 3 replications. The experiment comprised 5 treatments, viz. RDF (18 kg N + 48 kg P_2O_5 + 24 kg K_2O/ha), half RDF + 2% urea spray at 40 DAS, half RDF + 2% NPK mixture (12 : 32 : 16) spray at 40 DAS, RDF + micronutrients (Zn EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS and half RDF + micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS were kept in main plots and 4 treatments such as weedy check, imazethapyr 10% SL @ 0.075 kg/ha post-emergence (PoE), 20 DAS, pendimethalin 30% EC @ 1 kg/ha pre-emergence (PE) + hand-weeding (HW), 30 DAS and pendimethalin 30% EC @ 1 kg/ha PE + imazethapyr 10% SL @ 0.075 kg/ha PoE, 20 DAS in sub-plots.

The field was prepared by mould board plough followed by harrowing and levelling to ensure proper drainage. The N: P: K mixture of 12 : 32 : 16 grade was applied in gross plot, uniformly @ 150 kg/ha as basal at the time of sowing. Pant Mung 5, a short-duration variety @ of 25 kg seed/ha was used for sowing and furrows were opened manually at a distance of 30 cm apart with the help of furrow opener to a depth of 6 to 7 cm. Hand-weeding operation as per treatment, was carried out by *khurpi* trowel at 30 DAS. Weedy plots remained infested with native population of weeds till the harvesting of the crop. The crop was harvested manually from net plot area of 4 m × 1.8 m and kept for a period of 1–2 days, thereafter; plants were tied plot-wise into bundles and taken to the threshing floor. Weed population was studied with the help of a quadrate (50 cm × 50 cm) placed in the second row in the different corners of the plot for observations. The weeds falling within the quadrate were identified, counted species-wise at 30, 45, 60 DAS and at harvesting. The total number of weeds/m^2 area was calculated by multiplying the population in quadrates with a constant 4. Weed samples were collected from the ground surface and put in an envelope, sun-dried and transferred to a hot air oven at 70 ± 2°C temperatures till the constant weight. The weight of weeds was expressed as g/m^2. Weed-control efficiency was calculated in relation to total weed dry weight as per Mani *et al*. (1981) and expressed in per cent.

$$WCE = \frac{(DWC - DWT)}{DWC} \times 100$$

where, WCE, weed control efficiency; DWT, dry weight of weeds in treated plots (g) and DWC, dry weight of weeds in un weeded control plot (g).

Different fertility levels and weed-management practices influenced the total weed density significantly at all the stages of crop growth (Table 1). Total weed density was the maximum at different stages of crop growth in weedy check plot due to severe weed infestation. Among the fertility levels, application of recommended dose of fertilizer + micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS resulted in significantly higher weed density than the remaining other treatments except RDF (18 kg N + 48 kg P_2O_5 + 24 kg K_2O/ha) at 30 and 45 DAS which did not differ significantly. At 60 DAS and harvesting stage, half RDF + 2% NPK mixture (12:32:16) being at par with half RDF + 2% urea spray at 40 DAS which was at par with the application spray at 40 DAS recorded significantly higher total weed density than the remaining other treatments. Lower weed density was found at 30 to 45 DAS at the stages of crop growth with the application of half RDF + micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS. The total weed density increased by 46.3 and 34% with the application of RDF + micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS, 30 to 45 DAS stage, respectively, over half RDF + micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS and 30 to 45 DAS. Treatment F_4 revealed that higher crop nutrition increased the total weed population at all the stages of crop growth (Fig. 1). Among the weed-management practices, an application of the pendimethalin 30% EC @ 1 kg/ha PE + HW at 30 DAS resulted in significantly lower weed density than the re-

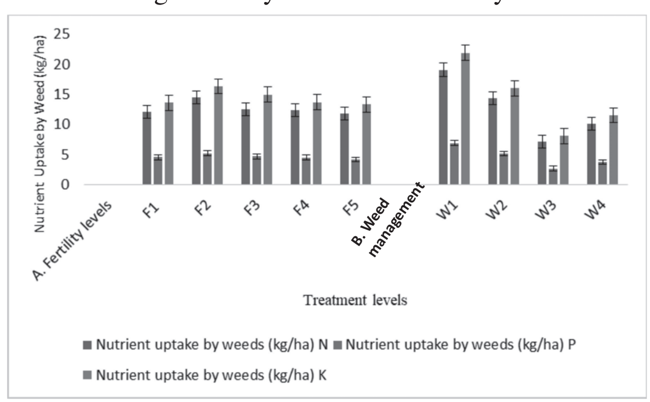

Fig. 1. Effect of fertility levels and weed-management practice on nutrient uptake by weeds in summer mung bean [F_1, RDF (18 kg N+ 48 kg P_2O_5 + 24 kg K_2O/ha); F_2, half RDF + 2% urea spray at 40 DAS; F_3, half RDF + 2% NPK mixture (12 :32:16) at 40 DAS; F_4, RDF + micronutrients spray (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate (0.1%) at 20 and 40 DAS; F_5, half RDF + micronutrients spray (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) at 20 and 40 DAS; W_1, weedy check; W_2, imazethapyr 10% SL @ 0.075 kg/ha PoE, 20 DAS; W_3, pendimethalin 30% EC @ 1 kg/ha PE + HW, 30 DAS; W_4, pendimethalin 30% EC @ 1 kg/ha PE + imazethapyr10% SL @ 0.075 kg/ ha PoE, 20 DAS]

Table 1. Effect of fertility levels and weed-management practices on total weed density and dry matter at various stages, weed-control efficiency (WCE) and yield in summer mung bean

Treatment	Total weeds density (Nos./m^2) Days after sowing				Total weeds dry matter (g/m^2) Days after sowing				WCE (%)	Grain yield (kg/ha)
	30	45	60	Harvesting	30	45	60	Harvesting		
Fertility levels										
RDF (18 kg N + 48 kg P_2O_5 + 24 kg K_2O/ha) (F_1)	13.9 (197.4)	14.0 (205.7)	12.6 (168.8)	11.7 (144.1)	5.7 (33.2)	6.8 (51.7)	9.3 (93.2)	13.3 (184.8)	36.7	843
Half RDF + 2% urea spray at 40 DAS (F_2)	12.5 (161.9)	12.6 (168.7)	14.3 (218.5)	13.2 (186.0)	5.4 (29.2)	7.3 (61.4)	10.2 (111.0)	14.7 (222.9)	32.2	672
Half RDF + 2% NPK mixture (12 : 32 : 16) at 40 DAS (F_3)	12.2 (152.6)	12.7 (169.2)	14.4 (218.0)	13.2 (183.0)	5.2 (27.2)	6.8 (51.8)	9.8 (104.3)	14.0 (205.4)	34.3	594
RDF + micronutrients spray (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate (0.1%) at 20 and 40 DAS (F_4)	14.3 (210.0)	14.6 (225.0)	13.3 (185.1)	12.0 (152.2)	6.0 (37.5)	6.7 (48.0)	9.4 (93.3)	13.3 (184.6)	34.3	853
Half RDF + micronutrients spray (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) at 20 and 40 DAS (F_5)	11.8 (143.5)	11.8 (148.0)	11.0 (1 0.4)	10.5 (117.8)	5.2 (27.0)	6.2 (41.0)	9.6 (96.1)	13.3 (183.2)	32.9	546
SEm±	0.3	0.3	0.4	0.2	0.16	0.2	0.4	0.4	4.5	38
CD (P=0.05)	0.9	0.9	1.2	0.8	0.5	NS	NS	NS	NS	127
Weed management practices										
Weedy check (W_1)	15.5 (241.5)	18.2 (330.5)	17.5 (310.6)	15.9 (254.1)	7.0 (49.3)	10.1 (103.7)	12.9 (168.8)	17.3 (300.1)	00.0	431
Imazethapyr 10% SL @ 0.075 kg/ha PoE, 20 DAS (W_2)	13.8 (191.0)	13.6 (185.3)	13.7 (189.4)	12.9 (169.2)	5.5 (30.4)	7.2 (51.9)	10.6 (112.5)	14.7 (218.4)	26.2	492
Pendimethalin 30% EC @ 1 kg/ha P E + HW, 30 DAS (W3)	10.2 (103.6)	9.0 (82.1)	8.7 (77.5)	7.8 (70.6)	4.3 (18.4)	3.9 (14.6)	6.7 (45.4)	10.4 (109.2)	63.4	1064
Pendimethalin 30% EC @ 1 kg/ha PE + imazethapyr 10% SL @ 0.075 kg/ha PoE, 20 DAS (W4)	12.4 (156.2)	11.6 (135.7)	12.5 (159.3)	11.9 (142.8)	5.1 (25.7)	5.8 (33.7)	8.4 (71.6)	12.5 (157.0)	46.8	821
SEm±	0.29	0.3	0.3	0.3	0.1	0.2	0.3	0.3	2.7	31
CD (P=0.05)	0.8	0.9	0.9	0.9	0.3	0.6	0.8	0.9	8.0	91

maining treatments at all the stages of crop growth. Weedy check recorded higher weed population at all the stages of crop growth. Pendimethalin 30 EC @ 1 kg/ha + imazethapyr 10 SL @ 0.075 kg/ha at PoE at 20 DAS recorded significantly lower weed density than imazethapyr alone at 30 and 45 DAS, but the difference was not significant at 60 DAS and harvesting stage. Ramanathan and Chandrashekhran (1998); Kaur *et al.* (2010); and Kumar *et al*. (2016) and recorded similar findings. Different fertility levels did not influence the total dry matter of weeds significantly at 45 and 60 DAS and at harvesting stage but was found at 30 DAS. Weed-management practices significantly influenced the total dry matter of weed at all the growth stages. Among the fertility levels, application of RDF + micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS recorded higher total dry matter than the remaining treatments, except RDF at 30 DAS which did not differ significantly. Higher total weed dry matter in RDF+ micronutrients was recorded due to more crop nutrition. Among the weed-management practices, an application of the pendimethalin 30% EC @ 1 kg/ha PE + HW at 30 DAS recorded significantly lower total weed dry matter than the remaining treatments at all stages of crop growth. Pendimethalin + imazethapyr resulted in significantly lower total weed dry matter than imazethapyr alone at all the stages of crop growth, but significantly higher than pendimethalin 30% EC @ 1 kg/ha PE + HW at 30 DAS.

Among the weed-management practices, an application of pendimethalin at 30% EC @ 1 kg/ha PE + HW 30 DAS at resulted in significantly higher weed-control efficiency than the other treatments. In the other weed-management treatments, pendimethalin 30% EC @ 1 kg/ha PE + imazethapyr 10% SL @ 0.075 kg/ha PoE at 20 DAS recorded significantly higher weed-control efficiency than imazethapyr 10% @ 0.075

kg/ha PoE at 20 DAS and weedy check. The lowest weed-control efficiency was recorded in imazethapyr 10% @ 0.075 kg/ha PoE at 20 DAS. Our results confirm the findings of Rao *et al*. (2015).

Among the fertility levels, the higher grain yield was recorded with the application of RDF + micronutrients spray at 20 and 40 DAS as compared to fertility levels except RDF which did not differ significantly. Half RDF + micronutrients spray at 20 and 40 DAS remained statistically at par with half RDF + 2% NPK mixture (12:32:16) spray at 40 DAS and half RDF + 2% urea spray at 40 DAS resulted in lower grain yield than rest of the fertility levels. The grain yield increased by 36% with the application of RDF + micronutrients (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) spray at 20 and 40 DAS over the half RDF + micronutrients spray (Zn-EDTA 0.045% + boric acid 0.1% + ammonium molybdate 0.1%) at 20 and 40 DAS. The yield increased owing to increased plant height, higher number of leaves, number of branches, number of pods, grain yield/plant and also higher number of grains/pod, 1,000-grain weight in the same treatments. The results are in corroboration with the findings of Patra and Bhattacharya (2009), who reported from Medinipur, West Bengal, that combined application of 0.05% solution of ammonium molybdate and 0.2% solution of borax resulted in 78.4% (726.7 kg/ha) increase in seed yield over the control. Biswas *et al*. (2009) also reported that, the spray of ammonium molybdate increases the *Rhizobium* activity and biological nitrogen fixation. The highest seed yield (957 kg/ha) was recorded with 75 kg/ha phosphorus owing to higher number of pod/plant and test weight. Among the weed-management practices, the application of pendimethalin 30% EC @ 1 kg/ha PE + HW 30 DAS, recorded significantly higher grain yield than the other treatments. The lowest grain yield was recorded in weedy check which statistically remained at par with the imazethapyr 10% SL @ 0.075 kg/ha PoE at 20 DAS. The pendimethalin 30% EC @ 1 kg/ha at PE + HW at 30 DAS could result in 59.5% higher grain yield over the weedy check. The increase in the grain yield might be because of increased yield-attributing characters mainly due to maintenance of weed free environment, especially during the initial growth stages of the crop. The reduction in crop–weed competition helped in better growth and development of mung bean crop resulted in higher grain yield. The lowest grain yield was obtained in weedy check compared with the other treatment due to more crop–weed competition throughout the life-cycle.

The fertility levels did not influence the N, P and K uptake by weed significantly. The weed-management practices significantly influenced N, P and K uptake. The lowest N, P and K uptake by weeds was recorded with the application of pendimethalin 30% EC @ 1 kg/ha PE + HW (30 DAS), being significantly lower than the remaining treatments. Pendimethalin + imazethapyr recorded significantly lower N, P and K uptake than imazethapyr but significantly higher than pendimethalin 30% EC @ 1 kg/ha PE + HW (30 DAS). The maximum uptake of N, P and K by weeds under weedy check because the uptake of nutrient depends on total dry matter produced by weeds and maximum total dry matter of weeds in weedy check treatments and minimum in weed-free condition.

Thus, it can be concluded that recommended dose of fertilizer (18 kg N + 48 kg P_2O_5 + 24 kg K_2O/ha) along with 1 kg/ha spray of pendimethalin (PE) + 1 HW at 30 DAS was best for achieving higher yield and better weed management in summer mung bean.

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