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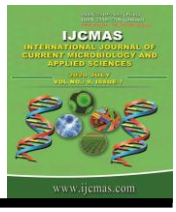

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Influence of Weed Management Practices on Growth and Nutrient Uptake of Spring Planted Sugarcane in Eastern Uttar Pradesh, India

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A B S T R A C T

A field experiment was conducted during the year 2017-2018 at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) to study the effect of various herbicides on growth attributes and nutrient uptake in sugarcane (*Saccharum officinarum* L.). The experiment comprises nine treatments laid out in Randomized Complete Block Design (RCBD) replicated thrice. The treatment consists of *viz.*T_1- Diuron @ 2.4 kg/ha PE(Pre-emergence), T_2-Diuron @ 3.2 kg/ha PE, T_3- Diuron @ 2.4 kg/ha 2-4 leaf stage of weed, T_4- Diuron @ 3.2 kg/ha 2-4 leaf stage of weed, T_5-Paraquat @ 0.5 kg/ha EPo(Early post emergence), T_6-2,4-D Na+ salt @ 2.6 kg/ha 2-4 leaf stage of weed, T_7- Metribuzin @ 1.5 kg/ha PE,T_8–Hand weeding (60, 90 and 120 DAP) and Untreated control (T_9) also included to make comparison of the treatments. The results have been found that all the weed control measure significantly improved the crop growth parameter and nutrient uptake of crop in comparison to weedy check. Among all the weed management practices hand weeding was found significantly superior over rest of the treatments, however in chemical weed management practices application of diuron @3.2 kg/ha at 2-4 leaf stage of weed recorded statistically more Nitrogen, Phosphorus and Potassium uptake of crop thandiuron applied pre-emergence, metribuzin, paraquat and 2,4-D. Moreover all the growth attributes number of shoots, shoot height, and dry weight of shoot was also recorded maximum in diuron @3.2 kg/ha at 2-4 leaf stage of weed among all the herbicides.

Introduction

Sugarcane (*Saccharum officinarum* L.) is an important sugar crop probably originated in New Guinea and from there it spread to the rest of the world. It is widely cultivated in India since time immemorial (Lal *et al.*, 2006). It occupies a very prominent position on the agricultural map of India covers an area of 5.03 million hectare (mha) with an average productivity of 70.86 tonne per hectare(Indian Agriculture, 2014) and ranks second (after Brazil) in the world in cane sugar production with annual production of 30.5 million tonnes (USDA, 2016).

It provides necessary raw materials to industries like sugar mills, chipboard paper and one of the largest agro-processing industries in the rural sector and a major source of income for farming community and generates employment for the youth of India. Sugarcane is a long duration crop faces tough competition with weeds between 60 to 120

days of its planting which causes heavy reduction in cane yield ranging from 40-67% (Chauhan and Srivastava, 2002). The yield reductions due to weeds (grassy, broad leaved and sedges) varied from 26% to 75% in unweeded control plots (Patel *et al.,* 2006), therefore weed control during this period is of great important.

The crop also need frequent irrigation and fertilizer application during early crop growth thereby increase the weeds menace many folds in the crop (Singh el al., 2008). This lower productivity is mainly due to heavy weed infestation in the early growth stage and poor weed management practices (Srivastava *et al.,* 2002).

Initial slow growth and wider row spacing provide ample opportunity for weeds to occupy the vacant spaces between rows and offer serious crop weed competition (Begum *et al.,* 2016). To realize the full potential of sugarcane, timely weed management is one of the most important factor otherwise there are chances of huge loss to farmers in terms of time and money. It is well-understood that manual weed management is most effective to control weeds but now day scarcity in availability of labours due to drift from villages to cities make delayed and ineffective (Kundu *et al.,* 2020).

Chemical control of weeds has been found to be economical in sugarcane (Chauhanel *et al*., 1994).Some herbicides applied Pre-emergence typically control weeds for 2 to 3 months in sugarcane. However, Pre-emergence herbicides do not generally provide season-long weed control in sugarcane. The objective of conducting this experiment to compare the efficacy of herbicides applied at Pre-mergence, Post-emergence, early post-emergence and 2-4 leaf stage of weed on sugarcane growth and uptake of nutrient by the crop.

Materials and Methods

The field experiment was conducted in spring seasons of 2017-18 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (25º18′ N latitude, 83º30′ E longitudes and at altitude of 76.10 m above the MSL (mean sea level) in Uttar Pradesh (India). The site was well drained and soil was sandy loam, non-saline with pH of 7.4 (Jackson, 1973), low in organic carbon (0.43%-Walkley and Black, 1934) and nitrogen (205.3 kg/ha available nitrogen-Subbiah and Asija, 1956), moderate in available phosphorus (22.8 kg/ha-Olsen, 1954) and available potassium (208.5 kg/ha-Jackson, 1973).

The experiment was laid out in randomized complete block design having nine treatments with three replication and plot size 4.5m x 5m.The treatment consists of *viz.* T_1- Diuron @ 2.4 kg/ha PE, T_2- Diuron @ 3.2 kg/ha PE, T_3- Diuron @ 2.4 kg/ha 2-4 leaf stage of weed, T_4- Diuron @ 3.2 kg/ha 2-4 leaf stage of weed,T_5-Paraquat @ 0.5 kg/ha EPo, T_6-2,4-D Na+ salt @ 2.6 kg/ha 2-4 leaf stage of weed, T_7- Metribuzin @ 1.5 kg/ha, T_8 – Hand weeding (60, 90 and 120 DAP) and Untreated control (T_9) also included to make comparison of the treatments. The treatments were allocated randomly to each plot using Fisher and Yates Random Table (Panse and Sukhatme, 1985). Seed canes were taken from healthy plant crop of variety Co 0238, free from pests and diseases.

Planting of cane sets was done by manual labour in 10 cm depth of furrow open by using spade and planting of set with bud to bud arrangement having row spacing 75cm. The sets were treated with trichoderma 0.2% (20g/l) solution before planting to prevent from sets borne diseases. Herbicides were applied as per treatment by using a foot sprayer fitted with flat fan nozzle as spray

using 700 litres of water per hectare. Recommended package of practices were followed to raise the crop. The crop was uniformly fertilized with 120 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare giving half of the nitrogen and full dose of phosphorus and potassium as basal in furrows. Remaining nitrogen was top dressed in two equal splits at 60 and 90 days after planting. Five representative shoots (tillers) were selected randomly per plot and height of all five shoots were measured from the tip of the top most leaf to the base of stem with the help of meter scale and values obtained were summed, averaged and expressed in centimeter (cm).

Total number of shoots (tillers) per net plot was counted and was tabulated into hectare basis. Stalk, green top and trash were separated and cut into small pieces and a representative sample of stalk, green top and leaves was taken from each plot and kept for drying in a oven at $70^0C \pm 5^0C$ until constant weight. After recording oven dry weight, the sample was ground treatment-wise in Willey's mill separately and stored in butter paper covers. The powdered samples were used for chemical analysis of total nitrogen, phosphorus and potassium using standard analysis process Micro-kjeldhal, Vandomolybdate yellow colour method and Flame-photometric method respectively. The uptake of nutrient by different part of cane was calculated by using per cent content and dry matter as follows:

$$\text{Nutrient uptake of Crop (kg/ha)} = \frac{\text{Per cent N/ P/ K in stalk/green top/trash X dry matter (kg/ha)}}{100}$$

The primary data generated through observations and laboratory analysis during the investigation was statistically analyzed using the techniques of the analysis of variance (ANOVA) and the differences among the treatment means were tested with the help of 'F' (variance ratio) test.

Treatment mean data were assessed by Critical Difference (CD) probability of $P \leq 0.05$ level of significance was determined for each characters to compare the differences among treatment means as outlined by Gomez & Gomez (1984).

Results and Discussion

Effect on growth attributes

The perusal of data (Table1) shows that significantly maximum number of shoots (000/ha) was found with three hoeing (at 60, 90 and 120 DAP). Amongst herbicidal treatments, application of diuron 3.2 kg/ha at 2-4 leaf stage recorded highest number of shoot (000/ha) which was significantly superior over rest of the treatments. This treatment was closely followed by diuron 2.4 kg/ha at 2-4 leaf stage.

Further, data showed that treatments T_1, T_2, T_5 and T_7 were comparable with each other, but showed their superiority over treatment T_6 and T_9. Moreover, significantly minimum number of shoots was recorded under weedy check. The further execution of data (Table 1) in respect to shoot height found that three hands weeding at 60, 90 and 120 DAP recorded significantly tallest shoot as compared to rest of the treatments. Application of diuron 3.2 kg/ha at 2-4 leaf stage recorded significantly tallest shoot among all herbicidal weed management practices and was superior over other treatments. The second best treatment in respect of shoot height was diuron 2.4 kg/ha at 2-4 leaf stage. Pre-emergence application diuron 2.4 kg/ha remained statistically similar with treatment T_2, T_5 and T_7, but all of these were superior over 2,4-D Na+ salt 2.6 kg/ha at 2-4 leaf stage. Moreover analysis of table1clearly indicates that all weed control treatments had significant effect on dry weight of shoot at all the crop growth stages.

Significantly highest shoot dry weight was recorded with hand weeding (at 60, 90 and 120 DAP) at all stages of observation compared to all other treatments. Among herbicide, application of diuron 3.2 kg/ha at 2-4 leaf stage recorded significantly highest shoot dry weight closely followed by diuron 2.4 kg/ha at 2-4 leaf stage. Pre emergence application of diuron 3.2 kg/ha was superior over 2,4-D Na+ salt 2.6 kg/ha at 2-4 leaf stage, but remained at par with diuron 2.4 kg/ha PE, paraquat 0.5 kg/ha EPO, and metribuzin 1.5 kg/ha PE.

Effects on nutrient uptake of crop

The data (table2) revealed that maximum nitrogen uptake was associated with hand weeding a (60, 90 and 120 DAP) which was significantly higher than other treatments. Among weedicides, application of diuron 3.2 kg/ha at 2-4 leaf stage recorded significantly higher nitrogen uptake. Pre-emergence application of diuron 3.2 kg/ha PE which was on par with diuron 2.4 kg/ha as PE, paraquat 0.5 kg/ha EPO and metribuzin 1.5 kg/ha PE recorded significantly higher nitrogen uptake of cane stalk, green top and trash than 2,4-D Na+ salt 2.6 kg/ha at 2-4 leaf stage. In case of phosphorus and potassium uptake similar trend was recorded.

Discussion

Effects on growth attributes

The number of shoots (000/ha) recorded 120 DAP (Table 1) exhibited significant variation owing the weed control treatments. It might have been due to the fact that sugarcane crop starts tillering about 60 days after planting and with advancement of crop growth number of shoots increased upto maximum tillering stage (120 DAP). Such enhance in number of shoots might have been due to formation of new tillers during this period.

A declining trend was observed with further advancement in crop age after 120 days possibly due to intra-specific competition among the growing shoot leading to exclusion of late formed tillers. Jeyaraman *et al.*, (2002), also have similar conclusion in respect to number of shoots. All the weed control treatments led to an improvement in tillering of crop though the superiority was established by three weeding at 30, 60 and 90 DAP of sugarcane. Hand weeding is the most effective weed management practice was also reported in literature (Singh *et al.*, 2012). Beneficial effect of weed control treatments on shoot population might have been due to suppression of weeds leading to reduced competition with crop plant for various resources viz. Nutrient, moisture, space etc. Diuron @ 3.2 kg/ha at 2-4 leaf stage of weed was next treatment in increasing number of shoots. The significant effect of herbicidal treatments in increasing trend in number of shoots after 60 to 120 DAP stage was also reported by Kathiresan *et al.*, (2004).The shoot length varied under different weed management practices significantly than untreated (Table 4.14). The reason behind this could be increased availability of nutrient due to control of weeds which led to increase in the shoot length. The largest shoot height was recorded in hand weeding (60, 90 and 120 DAP). Increase in height due to hand weeding is also reported by Choudhary *et al.*, (2016).

In the case of dry weight of shoots was significantly higher under different weed management treatments in respect to weedy condition. This might have been due to increased availability of nutrient due to suppression of weed growth which might have played a key role in increased fresh and dry matter accumulation by crop and also may due to increase shoot length and number of green leaves per shoot, since photo synthetically active surface is crucial in assimilation of CO_2, to produce dry matter.

Table.1 Effects of different weed management practices on growth attributes recorded at 120 DAP* in sugarcane

Treatments	No. of shoot (number 000/ ha)	Shoot height (cm)	Dry matter accumulation (g/shoot)
T_1-Diuron 80 DF @2.4 kg/ha Pre-emergence	99.67	249.33	73.30
T_2-Diuron 80 DF @ 3.2 kg/ha Pre- emergence	103.00	250.43	76.47
T_3-Diuron 80 DF @ 2.4 kg/ha 2- 4 leaf stage**	110.00	257.17	83.17
T_4- Diuron 80 DF @ 3.2 kg/ha 2- 4 leaf stage	116.09	264.73	92.67
T_5-Paraquat 24 SL @ 0.5 kg/ha Early- post emergence	97.81	247.22	72.87
T_6-2, 4- D Na salt 70% WP @ 2.6 kg/ha 2- 4 leaf stage	79.67	238.35	64.14
T_7-Metribuzin 70% WP @ 1.5 kg/ha Pre- emergence	98.17	248.17	71.82
T_8-Hand weeded(60, 90, 120)	122.33	272.97	103.00
T_9 -Weedy check	74.20	235.77	53.72
SEm±	1.68	1.48	1.68
CD (*P*=0.05)	5.04	4.45	5.05

CD= Critical Difference, *DAP- Days After Planting, ** 2-4 leaf stage of weed

Table.2 Effects of different weed management practices on uptake of Nitrogen, Phosphorus and Potassium in sugarcane

Treatments	Nitrogen uptake (kg/ha)			Phosphorus uptake (kg/ha)			Potassium uptake (kg/ha)		
	Stalk	Green top	Trash	Stalk	Green top	Trash	Stalk	Green top	Trash
T_1-Diuron 80 DF @2.4 kg/ha Pre-emergence	103.16	38.89	21.02	16.07	3.32	3.13	122.23	44.53	22.20
T_2-Diuron 80 DF @ 3.2 kg/ha Pre- emergence	110.73	40.25	22.77	16.31	3.34	3.30	126.28	45.61	23.60
T_3-Diuron 80 DF @ 2.4 kg/ha 2- 4 leaf stage	138.87	49.04	31.24	19.62	4.08	4.18	170.60	57.91	34.41
T_4- Diuron 80 DF @ 3.2 kg/ha 2- 4 leaf stage	172.01	57.59	39.79	23.94	4.89	5.45	217.70	71.53	46.44
T_5-Paraquat 24 SL @ 0.5 kg/ha Early- post emergence	97.96	37.04	17.52	15.74	3.25	2.82	116.09	42.66	20.46
T_6-2, 4- D Na salt 70% WP @ 2.6 kg/ha 2- 4 leaf stage	80.49	30.53	12.42	12.53	2.60	1.98	79.13	32.67	12.46
T_7-Metribuzin 70% WP @ 1.5 kg/ha Pre- emergence	100.17	37.37	19.17	15.92	3.28	3.05	119.21	43.87	21.40
T_8-Hand weeded(60, 90, 120)	206.90	67.93	49.74	28.33	5.80	6.71	274.93	86.58	60.73
T_9 -Weedy check	66.02	26.39	8.18	9.65	2.04	1.23	50.03	24.05	6.84
SEm±	9.35	1.88	1.99	0.85	0.15	0.25	10.35	2.35	2.23
CD (*P*=0.05)	28.03	5.64	5.96	2.54	0.45	0.74	31.03	7.05	6.64

Manual hoeing (60, 90 and 120 DAP) recorded highest fresh and dry weight. Among the herbicide treatments highest fresh and dry weight was recorded with the application of diuron @ 3.2 kg/ha as 2-4 leaf stage of weed. Superiority of these treatments over others might have been attributed to their efficacy in suppressing the weed growth. These findings are in conformity with Singh *et al.,* (2011); Farookh *et al.,* (2014).

Effects on nutrient uptake

Significantly higher content of N, P and K in cane stalk, green tops and trash was recorded due to weed control treatments (Table 2). Nutrient uptake is the function of N, P and K content in the cane, green tops and trash and dry matter production of the sugarcane. It was significantly highest under manual weeding (60, 90 and 120 DAP) followed application of diuron @ 3.2 kg/ha at 2-4 leaf stage of weeds.

Increase availability of N, P and K under these treatments as a result of suppression of weeds growth might have been the driving force behind higher dry matter production and nutrient uptake in sugarcane. Similar result has also been reported by Almubarak *et al.*, (2012), Choudhary *et al.,* (2015).

With the above findings it was found that the hand weeding was the best to manage weed in sugarcane crop however, due the labour scarcity its suitability in socio-economic condition of the farmers is problem.

Among the herbicides diuron @ 3.2 kg/ha at 2-4 leaf stage of weeds was found superior in comparison to other weed management practices followed by diuron @ 2.4 kg/ha at 2-4 leaf stage of weeds in respect to number of shoots, shoots height, dry matter accumulation of shoots and uptake of Nitrogen, Phosphorus and Potassium of the crop.

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