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INFLUENCE OF WEED MANAGEMENT PRACTICES ON PRODUCTIVITY AND NUTRIENT UPTAKE BY DIRECT SEEDED RICE (*ORYZA SATIVA* L.) IN CALCAREOUS SOIL

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ABSTRACT
A field experiment was carried out at the Research Farm, Rajendra Agricultural University, Pusa, Samastipur, Bihar. The study was comprised of twelve weed management combination in Randomized Block Design with three replications. Three hand weeding at 20, 40 and 60 days after sowing (DAS) had registered the maximum Plant height (111.27 cm), Number of tillers/m^2 (370.00) LAI at 60 DAS (6.86), CGR at 90 DAS (11.10 g/m^2/day), Number of panicles per meter square (286.67), panicle length (25.77 cm) and filled grain per panicles (112.8) and grain yield (41.73 q/ha) of direct seeded rice, which remain comparable with Pendimethalin1 L/ha *fb* (followed by) Bispyribac-Na 30 g /ha + Hand weeding, Pendimethalin 1 L/ha *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha. The maximum nitrogen (67.92 kg/ha), phosphorus (17.16 kg/ha) and potassium (72.30 kg/ha) uptake was recorded under weed free treatment which remain comparable with Pendimethalin1 L/ha *fb* Bispyribac-Na 30 g /ha + Hand weeding, Pendi methalin 1 L/ha *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha. Thus, highest grain yield, yield attributes and nutrient uptake obtained by weed free treatment which was at par with Pendimethalin1 L/ha *fb* Bispyribac-Na 30 g /ha + Hand weeding.

INTRODUCTION

Rice is the world's most important crop and more than half of the world's population depends on it for food, calories and protein especially in developing countries. It is staple food of the world population and grown in different agro-ecosystems across the world. Khush (1997) has categorized rice land ecosystems into four types. According to FAO (2007), rainfed lowland area has been estimated 30.9 % worldwide and 32.1 % in Asia. The rain fed area which constitutes about 63 % (89 mha) of the cultivated area of India accounts for only 40 % of the total food production whereas 37 % (53 mha) of the irrigated area contributes 60 % to the national food basket (Kar *et al*., 2004). The rainfed lowland rice ecosystem is characterized by its lack of control over the water and by both flooding and drought problems. In India, rice was traditionally grown under puddle transplanted condition, where standing water does not allow weeds to emerge (Pathak *et al*., 2011). However, immense labor and water is required to grow rice by puddle transplanted system. Due to declining water resources and scarcity of labor, the conditionally puddle rice system is losing its sustainability and economic viability (Akbar *et al*., 2011). Direct seeding offers certain advantages *i.e.* saves labour, faster, easier, timely sowing, less drudgery, early crop maturity by 7–10 days, less water requirements, higher tolerance to water deficit, often higher yield, low production cost, more profit, better soil physical conditions for crop (Balasubramanian and Hill, 2002). Despite several advantages, various production obstacles are also encountered in direct seeded rice (DSR) cultivation. Weeds are one of the major problem in direct seeded rice. Aerobic soil conditions and dry tillage practices, besides alternate wetting and drying conditions are conducive for germination and growth of highly competitive weeds, which cause 40-100% loss in grain yield (Choubey *et al*., 2001).Weed infestation is the major threat to yield and further expansion of DSR throughout the world (Singh *et al*., 2015). Any delay in weeding will lead to increased weed biomass which has a negative correlation with yield. Hand weeding is effective and most common method to control weeds in this crop. However, scarcity and high wages of labor, particularly during peak period and early crop-weed competition make this operation uneconomical and unaffordable to the poor farmers (Heisnam *et al*.,2015). Herbicides presently used in rice are mainly pre-emergence and weeds coming at later stages of crop growth are not controlled by pre-emergence herbicides. Single application of a particular herbicide seldom furnishes adequate weed control in direct seeded rice. Thus, Khaliq *et al*. (2011) suggested that both pre and post emergence herbicides, if properly used were quite effective in suppressing weeds in DSR. Apart from hand weeding and herbicides, there is another option of brown manuring which is showing promising results (Mandal *et al*., 2011). Hence, the present investigation was carried out to study the effect of different weed management practices and combination of pre as well as post-emergence herbicides for controlling complex weed flora, yield attributes, grain yield and nutrient uptake by direct seeded rice.

MATERIALS AND METHODS

A field experiment was conducted during the *kharif* season in

2014 at the Agricultural Research Farm of Rajendra Agricultural University, Pusa, Samastipur, Bihar (25.59º N, 84.40º E and 52.3 m above the mean sea level). The soil was calcareous (sandy-loam) having bulk density 1.17 g/cc, pH 8.43, low in Organic carbon 0.46%, available nitrogen (242 kg/ha), available phosphorus (18.38 kg/ha) and available potassium (111 kg/ha).The experiment was laid out in randomized block design, which was replicated thrice. The factor comprised of 12 weed management treatments on direct seeded rice *i.e.* T_1-Weedy check, T_2-Weed free (3 hand weedings at 20, 40 and 60 Days after sowing, DAS), T_3-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS), T_4-Pendimethalin 1 L/ha (2 DAS) *fb* (followed by) Bispyribac-Na 30 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS),T_5-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 15 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS), T_6-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 15 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS), T_7-Pendimethalin 1 L/ha (2 DAS) *fb* Pendimethalin 1 L/ha + Bispyribac-Na 30 g/ha in tank mix (20 DAS), T_8-Pendimethalin 1 L/ha (2 DAS) *fb* Pendimethalin 1 L/ha + Bispyribac-Na 15 g/ha in tank mix (20 DAS), T_9-Bispyribac-Na 30 g/ha + Pyrazosulfuron 25 g/ha in tank mix (20 DAS), T_{10}-Bispyribac-Na 30 g/ha + Ethoxysulfuron 18.5 g/ha in tank mix (20 DAS), T_{11}-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha (20 DAS) + Hand weeding (40 DAS), T_{12}-Brown manuring with *Sesbenia aculeate* at 35 DAS. For brown manuring, dhaincha (*Sesbania aculeate*) @ 40 kg/ha was broadcasted at the time of rice sowing and knock down with 2, 4- D @ 0.75 kg/ha at 35 DAS. The gross plot size under each treatment was 30 m^2 and the net plot size was 20.8 m^2. As the trial was conducted in rainfed lowland ecosystem, Swarna sub-1 which is the submergence tolerant variety was taken as a test crop. Rice variety 'Swarna Sub-1' was line sown at the row spacing of 20 cm with 30 kg seeds per ha on 26th June 2014. Seeds was sown directly in unpuddled (1 harrowing + 2 cultivator + 1 levelling) conditions and harvested on 18th November 2014. The nutrients were applied at the rate of 80, 40, 20 and25 kg/ha of N, P, K and $ZnSo_4$, respectively. The phosphorus, potassium and zinc sulphate were applied as basal dose and nitrogen was applied in three split *i.e.* basal, tillering and panicle initiation stages. The Plant height of randomly selected five tagged rice plants in net plot area were measured from the base of the plant to the tip of the upper most leaf and expressed as average plant height in centimetre. The number of panicles per meter square was counted from net plot size at the harvesting of crop. Randomly five panicles selected from each plot. Leaf area index was calculated for rice crop was work out at 60 DAS. The total leaf area was determined by length × maximum width method, the product being multiplied by a correction factor of 0.75 given by Yoshida (1981) for rice. Plants of one metre row length were uprooted from each plot from sampling row then washed, sun dried and then kept in oven at 70ºC+ 1 till constant weight reached. Then dry weight was taken with digital electronic balance and it was converted into g/m^2. These data were used to work out Crop growth rate (CGR). It is expressed as gram of dry matter produced per day/m^2. Number of filled grains per panicle calculated by counting the number of filled grains per panicle was average of five panicles. Grain yield was determined from the net plot area and was weighed in kg and converted into q/ha. The grain and straw samples was oven dried, processed and analysed for nitrogen, phosphorus and potassium content by adopting standard procedures (Bremner and Mulvaney, 1982, Koenig and Johnson, 1942 and Jackson, 1973, respectively). The herbicides were applied with battery-operated knapsack sprayer using spray volume of 500 litres water/ha. The weed density (No./m2) was worked out by counting number of weeds from randomly thrown of quadrate (1.0 m^2) at two place in each plot and average of two reading was done and after counting number of weeds, they are uproot from the plot for dry weight recording. They are sun-dried subsequently oven drying was done at 60ºC till constant weight reached. Thereafter weighing was done and average of two reading was recorded. Weed data were subjected to square-root transformation {"X+0.5} and analysed statistically. The herbicide dose was calculated using formula (Recommended herbicide/active ingredient) x100. Data pertaining to various parameters were subjected to statistical analysis by the technique of analysis of variance as described by Cochran and Cox (1962)

RESULTS AND DISCUSSION

Effect on crop, yield attributes and yield

Crop growth like plant height, leaf area index, crop growth rate and yield attributes like number of panicles at harvest, panicle length and number of filled grain per panicle are an important vegetative character as it is an index of plant growth and vigour, which ultimately reflected in its productivity. Screening of data showed significant impact of weed management on plant height was found significant. The longest plant (111.27 cm) was recorded under treatment T_2- Weed free (3 hand weedings at 20, 40 and 60 DAS), which was significantly superior to all other treatments (Table 1). This might be due to effective weed control by weed free treatment which resulted into less or nearly no crop weed competition for nutrient, light, moisture and space which ultimately leads to higher accumulation of photosynthate and subsequently resulted in longest plant height. This result is in close conformity of Mandal *et al*. (2011). The shortest plant height (97.73 cm) was recorded with treatment T_1-Weedy check (Table 1). This might be due to highest crop-weed competition in weedy check in which individual plants of the plots faced highest competition from weed population apart from crop plant. Hence crop did not get opportunity to proliferate laterally due to less lateral space. Bhurer *et al*. (2013), Parthipan *et al*. (2013 a) and Sharma *et al*. (2007) also reported similar findings. Among the herbicidal treatments the highest plant height (107.47 cm) recorded under T_3-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS), this might be due to effective and efficient control of weeds throughout critical period of crop growth, initially 20 days by pendimethalin1 L/ha (pre-emergence) and further with Bispyribac-sodium 30 g/ha + Azimsulfuron 30 g/ha resulted in increased growth of the crop. Similar opinion has also been expressed by Narolia *et al*. (2014). The maximum number of tillers /m^2 (Table 1) was recorded under the treatment T_2- Weed free (3 hand weedings at 20, 40 and 60 DAS, at 60 DAS), which was significantly superior over rest of the treatments

Table 1 : Effect of weed management on growth, yield attributes and yield of direct seeded rice.

Treatments	Plant height at harvest (cm)	No. of Tillers/m^2 at Harvest	No. of Panicle/m^2	Panicle length (cm)	No. of filled grains /panicles	LAI at 60 DAS	CGR at 90 DAS (g/m2/day)	Grain Yield (q/ha)
T_1-Weedy Check	97.73	251.67	180	22.53	89.87	4.88	6.46	22.33
T_2-Weed free (3 hand weeding at 20, 40 and 60 DAS)	111.27	370	286.67	25.77	112.8	6.86	11.1	41.73
T_3-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS)	107.47	348.33	265	25.33	111.53	6.23	10.62	39.8
T4-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS)	105.8	343.33	261.67	24.27	107.53	5.85	10.6	38.4
T5-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 15 g/ha + Azimsulfuron 30 g/ha in tank mix(20 DAS)	106.1	345	263.33	24.67	109.8	6.19	10.52	39.47
T6-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 15 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS)	99.91	305	240	23.07	100	5.22	9.21	36.97
T7-Pendimethalin 1 l/ha (2 DAS) *fb*Pendimethalin 1 l/ha + Bispyribac-Na 30 g/ha in tank mix (20 DAS)	102.27	321.67	250	23.2	100.8	5.46	10.5	37.23
T8-Pendimethalin 1 l/ha (2 DAS) *fb*Pendimethalin 1 l/ha + Bispyribac-Na 15 g/ha in tank mix (20 DAS)	99.8	296.67	238.33	22.93	98.33	5.11	10.33	36.07
T9-Bispyribac-Na 30 g/ha + Pyrazosulfuron 25 g/ha in tank mix (20 DAS)	100.44	308.33	241.67	23.13	100.6	5.24	10.38	37.14
T10-Bispyribac-Na 30 g/ha + Ethoxysulfuron 18.5 g/ha in tank mix (20 DAS)	99.14	283.33	236.67	22.8	97.8	5.07	8.48	35.73
T11-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha (20 DAS) + Hand Weeding (40 DAS)	109	360	285	25.47	112.4	6.26	10.78	41.07
T12-Brown manuring with *Sesbenia aculeate* at 35 DAS	105.27	341.67	260	23.93	107.33	5.78	10.44	37.87
SEm ±	2.7	12.31	8.5	0.92	3.21	0.21	0.37	1.32
C.D. (p = 0.05)	7.97	36.33	25.08	NA	9.48	0.61	1.08	3.91

Table 2: Effect of weed management on weed population and weed dry matter of direct seeded rice

Treatments	Weed Population at 60 DAS	Weed Population at 90 DAS	Weed dry matter at 60 DAS	Weed dry matter at 90 DAS
T_1-Weedy Check	7.63(57.67)*	7.22(51.67)*	4.22(17.30)*	5.08(25.32)*
T_2-Weed free (3 hand weeding at 20, 40 and 60 DAS)	3.44(11.33)	2.40(5.33)	2.01(3.58)	1.70(2.40)
T_3-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha +) Azimsulfuron 30 g/ha in tank mix (20 DAS	3.92(15.00)	3.13(9.33)	2.27(4.62)	2.22(4.44)
T_4-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS)	4.40(19.00)	3.71(13.33)	2.57(6.10)	2.55(6.02)
T_5-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 15 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS)	4.13(16.67)	3.32(10.67)	2.45(5.50)	2.36(5.12)
T_6-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 15 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS)	5.40(28.67)	4.80(22.67)	3.06(8.86)	3.33(10.60)
T_7-Pendimethalin 1 l/ha (2 DAS) *fb*Pendimethalin 1 l/ha + Bispyribac-Na 30 g/ha in tank mix (20 DAS)	5.05(25.00)	4.41(19.00)	2.87(7.72)	3.06(8.89)
T_8-Pendimethalin 1 l/ha (2 DAS) *fb*Pendimethalin 1 l/ha + Bispyribac-Na 15 g/ha in tank mix (20 DAS)	5.43(29.00)	4.84(23.00)	3.12(9.23)	3.43(11.29)
T_9-Bispyribac-Na 30 g/ha + Pyrazosulfuron 25 g/ha in tank mix (20 DAS)	5.14(26.00)	4.56(20.33)	3.02(8.64)	3.19(9.68)
T_{10}-Bispyribac-Na 30 g/ha + Ethoxysulfuron 18.5 g/ha in tank mix (20 DAS)	5.55(30.33)	4.98(24.33)	3.13(9.33)	3.45(11.42)
T_{11}-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha (20 DAS) + Hand Weeding (40 DAS)	3.52(12.00)	2.54(6.00)	2.06(3.74)	1.78(2.66)
T_{12}-Brown manuring with *Sesbenia aculeate* at 35 DAS	4.56(20.33)	4.02(15.67)	2.57(6.11)	2.78(7.21)
SEm ±	0.18(1.60)	0.16(1.22)	0.09(0.45)	0.09(0.50)
C.D. (p = 0.05)	0.52(4.72)	0.46(3.59)	0.26(1.32)	0.27(1.47)

*Values in parentheses show the original value

except T_3, T_4, T_5, T_{11} and T_{12} treatments. This finding is in close conformity with the results obtained by Singh *et al*. (2014), Mandal *et al*. (2011) and Majhi *et al*.(2009). Number of tillers at 60 DAS all the weed control treatments showed significantly superiority over T_1- Weedy check and was comparable to each other (weed control treatments) .This might be due to the facts that weed free environment helps the crop for better establishment and subsequence growth. Similar view was expressed by Dwivedi *et al*. (1994) and Tuteja *et al*. (1995). The poor LAI obtained with T_1- Weedy check (Table 1) might be due to low production of tillers and ultimately the number of leaves per plant, which was resultant effect of higher crop weed competition. Similar opinion has also been expressed by Dwivedi *et al*.(1994) andTuteja *et al*. (1995) and the maximum leaf area index recorded at 60 days after sowing. This might be due to maximum tillers/m^2 at 60 days after sowing. Similar result was also found by Majhi *et al*. (2009).The maximum leaf area index was recorded under T_2- Weed free (3 hand weedings at 20, 40 and 60 DAS) which was statistically at par with T_{11}- Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha (20 DAS) + Hand weeding (40 DAS) and this was found superior over rest of the treatments. This might be due to effective control of weeds by hand weeding as well as by herbicides, less crop weed competition throughout the crop

Table 3 : Effect of weed management on nutrient uptake of direct seeded rice

Treatments	Nutrient uptake(kg/ha) by Crop		
	N	P	K
T_1-Weedy Check	36.21	7.33	46.06
T_2-Weed free (3 hand weeding at 20, 40 and 60 DAS)	67.92	17.16	72.3
T_3-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS)	62.57	14.81	67.36
T_4-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS)	59.22	14.09	64.89
T_5-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 15 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS)	59.64	14.59	66.09
T_6-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 15 g/ha + Azimsulfuron 15 g/ha in tank mix (20 DAS)	54.73	12.21	60.17
T_7-Pendimethalin 1 l/ha (2 DAS) *fb*Pendimethalin 1 l/ha + Bispyribac-Na 30 g/ha in tank mix (20 DAS)	56.54	13.23	62.66
T_8-Pendimethalin 1 l/ha (2 DAS) *fb*Pendimethalin 1 l/ha + Bispyribac-Na 15 g/ha in tank mix (20 DAS)	53.76	11.96	58.92
T_9-Bispyribac-Na 30 g/ha + Pyrazosulfuron 25 g/ha in tank mix (20 DAS)	56.09	12.49	60.69
T_{10}-Bispyribac-Na 30 g/ha + Ethoxysulfuron 18.5 g/ha in tank mix (20 DAS)	51.65	10.75	57.11
T_{11}-Pendimethalin 1 l/ha (2 DAS) *fb*Bispyribac-Na 30 g/ha (20 DAS) + Hand Weeding (40 DAS)	65.2	15.3	70.37
T_{12}-Brown manuring with *Sesbenia aculeate* at 35 DAS	60.81	13.81	65.77
SEm ±	2.44	1.29	2.54
C.D. (p = 0.05)	7.2	3.82	7.48

growth period and crop enjoyed favorable conditions with respect to light, space, nutrients, CO_2 *etc.* These results are in conformity with the findings of Subramanian *et al*. (2006), Mandal *et al*. (2011) and Parthipan *et al*. (2013 b) they reported that the weed management practices improved the growth parameters by eliminating crop-weed competition at critical stages.

Higher crop growth rate was recorded under treatment T_2- Weed free (3 hand weedings at 20, 40 and 60 DAS) at 60 DAS (Table 1), which was mainly due to higher plant population and better accumulation of dry matter and significantly superior to $T_{10,}$ T_6 and T_1 and remains statistically at par with rest of the treatments. Similar result was found by Mandal *et al*. (2011) and Majhi *et al*. (2009). Crop growth rate (CGR) increased only up to 60 DAS and thereafter, decreased with advancement of crop age. It might be due to accumulation of food material through photosynthesis during period of the crop and then it distributed towards the root and Shoot. The similar result was also reported by Ramamoorthy *et al*. (1997).

The highest number of panicle per square meter (286.67) and number of fertile grain/panicle (112.8) was obtained under weed free (3 hand weedings at 20, 40 and 60 DAS) treatment (Dixit and varshney,2008) and lowest under weedy check (180.00 and 89.87, respectively) in Table 1. Better expression of growth parameters under the conditions in which plots were kept weed free is self explanatory. Application of T_3- Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS) treatments among herbicidal treatments resulted higher panicle length and filled spikelet/panicle. This might be due to significantly reduction in weed density and weed dry weight. Effective controls of weeds with pre-emergence and post-emergence application of herbicide might have resulted in increased yield attributes of the crop which reduces resource used by dynamic weed flora. These results are in accordance with the findings of Walia *et al*. (2009) Singh and Singh (2010) and Narolia *et al*. (2014). Singh *et al*. (2010) reported higher grain yield (Table 1) under hand weeding and herbicidal treatments which were attributed to better utilization of applied nutrients by crop as compared to Weedy check crop. The results were similar to that of the experiment at findings of Amarjeet *et al*. (2006).

Effect on weed

An appraisal of data regarding weed count at 60 (DAS) revealed that weed count was recorded significantly lowest (3.44/m^2) under treatment T_2- Weed free (3 hand weedings at 20,40 and 60 DAS) which was statistically at par with treatment T_{11}- Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha (20 DAS) + Hand Weeding (40 DAS)-(3.52/m^2),T_3-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS)-(3.92/m^2), and highest weed population (7.63 /m^2) were recorded under treatment T_1-weedy check. Citation of the data regarding of weed dry matter at 60 DAS as affected by different weed management treatments revealed that weed dry weight gets affected significantly lowest (Table 2). The lowest weed dry matter (2.01g /m^2) was recorded under treatment T_2- Weed free (3 hand weedings at 20,40 and 60 DAS) which was statistically at par with T_3-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS)-(2.27 g /m^2) and T_{11}-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha (20 DAS) + Hand Weeding (40 DAS)-(2.06 g /m^2) and highest weed dry weight (4.22 g/m^2) was recorded under treatment T_1-Weedy check treatment (Table 2). All weed control treatments were found effective over T_1-Weedy check at all the stages of crop growth in relation to weed population/m^2 and weed dry weight (g/m^2). Among the herbicide treatments, weed population/m^2 and weed dry weight (g/m^2) was registered significantly lowest under T_3-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS), at all crop growth stages was also observed with T_3-Pendimethalin 1 L/ha (2 DAS)

fb Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS). This may be attributed due to earlier and effective control of weeds by pendimethalin and subsequently flushes of weeds were controlled by Bispyribac-sodium and azimsulfuron efficiently. This result was similar to that of the experiment at findings of Narolia *et al*.(2014), Maity and Mukherjee *et al*. (2008) and Dixit and Varshney (2008). The lower weed density with that treatment might be due to inherent ability of chemical to affect the cell division, cell growth and hampering the germination of weeds. Similar findings were reported by Ramachandran *et al*. (2012). The lowest weed biomass observed with those treatments was due to efficient control of dominant weed from the beginning of crop growth (Ramachandran *et al*., 2012). It might be due to the use of mixture of herbicides which showed broad spectrum control of weeds. This finding is in conformity with those of Dadsena *et al*. (2014). Similarly weed dry weight was also registered significantly lower under T_2- Weed free (3 hand weedings at 20, 40 and 60 DAS) and it was statistically at par withT_{11}- Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha (20 DAS) + Hand Weeding (40 DAS) at 60 and 90 DAS. Hand weeding exhibited significant influence on weed population at all different growth stages. Significantly the lowest weed density was observed with hand weeding at all stages of crop growth. This might be due to timely reduction of weed below threshold level by intercultural tools. The weeds were uprooted and killed. Similar findings were observed by Pandey *et al*. (1996).

Effect on Nutrient uptake

Nutrient uptake being a function of dry matter production and partly due to increase in its concentration gave more total dry matter and registered significantly higher uptake of nitrogen, phosphorus and potassium (Singh *et al*., 2013). The nitrogen, phosphorus and potassium uptake both in grain and straw were higher in weed free plots. (Singh and Patel, 1989 and Mandal *et al*., 2011). All weed control treatments recorded significantly higher nitrogen, phosphorus and potassium uptake by crop plants than weedy check (Table 3). Among the herbicidal treatments maximum uptake of T_3-Pendimethalin 1 L/ha (2 DAS) *fb* Bispyribac-Na 30 g/ha + Azimsulfuron 30 g/ha in tank mix (20 DAS) by rice crop was obtained due to less weed infestations. This might be due to application of herbicides controlled weed effectively and made available more nutrients to rice crop and consequently resulted in higher yield. Similar findings had also been reported by Kumar *et al*. (2010).

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