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Herbicides combination effects on *Cyprus iria* and nutrient studies of transplanted rice in western Uttar Pradesh

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Abstract
A field experiment was conducted with the aim to know effects of different herbicide combination on *Cyprus iria* and nutrient studies of transplanted rice in western Uttar Pradesh during *Kharif* 2016 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, U. P. (India). The experimental site was sandy loam in texture, low in organic carbon and available N, medium in available P and K and slightly alkaline in reaction. The experiment was set in randomized complete block design with three replications comprising twelve weed management treatments. Among the different herbicidal treatments lowest populations of *Cyprus iria* was found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) and found at par with Pyrazosulfuron fb Azimsulfuron(150 g a.i ha^{-1} PE fb 30 g a.i ha^{-1} POE). The highest nitrogen, phosphorus and potassium content and uptake by weeds was found under weedy check while lowest 3.09 kg ha-1 in two hand weeding. Among the herbicides lowest nitrogen, phosphorus and potassium content and uptake at harvest stage was found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha-1PE fb 25g a.i ha-1POE) was at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha-1PE fb 30 g a.i ha-1POE), Anilophos fb Bispyribac Sodium (400 g a.i ha-1PE fb25g a.i ha-1POE) and Anilophos fb Azimsulfuron (400 g a.i ha-1PE fb 30 g a.i ha-1POE). This shows that Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1} POE) can be applied in transplanted rice for effective weed control, higher growth and productivity.

Keywords: nutrient uptake, herbicide, transplanted rice, and weed management

Introduction
This is posing a serious problem to even maintain the food grain production and leaving only the option of increasing the productivity of grain crops. Rice is second most important food crops of the world after wheat. Rice is major staple crop of the world to diet of 2.7 billion people and it contain 7-8% protein, 3% fat and 3% fiber. In India, rice occupies an area of 43.95 mha with production and productivity of 106.65 mt and 2.4 tonnes ha^{-1}, respectively **(**Anonymous, 2015-16). In India weeds were reported to contribute to highest crop yield losses as high as 37% in *kharif* season. Monocotyledonous weed density is inversely correlated with crop yield, whereas the correlations between transplanted rice yield and dicotyledonous and sedge weed densities are not significant. Heavy weed infestation is one of the major constraints in transplanted rice causing severe yield losses (Kabdal, *et al* 2014) [5]. Weeds emerge simultaneously with germination rice seedling resulting in severe competition for nutrient, light, and space. Weeds by virtue of their high adoptability and faster growth dominate the crop habitat reduce the yield potential (Hossain, *et al* 2014) [4]. The degree of rice – weed competition depends on crop factor i.e. cultivar, crop density, crop age, plant spacing etc. Effective weed control in transplanted rice is one of the major limitations hindering its wide spread cultivation. Hand pulling or hand weeding is time consuming, cumbersome and costly alternative. Hence for transplanted rice, the chemical method of weed management is most suited as it takes care of weeds right from beginning of crop growth and is cost effective (Shivaji, *et al* 2015) [1]. Keeping all these point in mind a field experiment was conducted with different weed management treatments including application of pre-emergence and post-emergence herbicides as sole and in combination to find out its effect on growth and productivity of transplanted rice in Indo-Gangetic Plain Zones of Western Uttar Pradesh.

Materials and Methods

Experimental Site

The experimental site has a semi-arid and sub-tropical climate characterized by hot summers and severe cold winters. The mean maximum temperature was noticed in the month of June, which is the hottest month of the year, ranges from 40° to 45°C. The mean annual rainfall is about 850 mm, of which nearly 80 per cent is received in the monsoon period from July to September and the remaining in the period between Octobers to May. Mean relative humidity attains the maximum value (70 to 77% or even more) during the monsoon season and the minimum (30 to 45%) during the summer months.

Treatments details

The study was undertaken at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut during *Kharif* season 2016. The experiment was conducted in randomized complete block design (RCBD) with three replications comprising twelve weed management treatments namely,T_1-Weedy check, T_2- two hand weeding,T_3- Butachlor (1.5 kg a.i ha^{-1}) fb One hand weeding, T_4-Pyrazosulfuron (150 g a.i ha^{-1}PE), T_5-Azimsulfuron (30 g a.i ha^{-1}POE), T_6-Oxidiargyl (100 g a.i ha^{-1}PE) fb one hand weeding, T_7-Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1}PE fb 25g a.i ha^{-1}POE),T_8- Pyrazosulfuron (150 g a.i ha^{-1}) fb one hand weeding, T_9-Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1}POE), T_{10}-Anilophos fbAzimsulfuron (400 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE),T_{11}-Azimsulfuron (30 g a.i ha^{-1}) fb one hand weeding and T_{12}-Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE). The soil of the experimental field was sandy loam in texture, low in organic carbon and available N, medium in available P and K and slightly alkaline in reaction. Rice cv. Pusa basmati 1 was transplanted during second fortnight of July, 2016 at 20 cm ×10 cm spacing and harvested in second fortnight of October, 2016. Recommended package and practices were followed for the cultivation of rice except weed management. The herbicides were applied as per treatment details. The required quantity of herbicide were applied with manually operated knapsack sprayer fitted with flat-fan nozzle using a spray volume of 500 litre water / ha.

Observations recorded

Different weed species present within three randomly selected 0.5 m x 0.5 m quadrate in each net plot area were counted and converted to number of weeds m^{-2} before subjecting to statistical analysis. The number of individual weed present in the field was recorded at 30, 60 and 90 DAT. Data on weed density and biomass were subjected to square-root transformation. Nitrogen, phosphorus and potassium contents were analyzed in weeds as well as crop plants at harvest by adopting modified micro-kjeldahl method for nitrogen, vanadaomolybdate yellow colour method for phosphorus and flame photometric method for potassium as described by Jackson. A representative sample for grain and straw was taken separately to determine respective dry matter production for each treatment plot wise. The uptake of individual nutrient was calculated by multiplying dry matter yield and respective nutrient content as under:

Total nutrient uptake (kg ha^{-1} or g ha^{-1}) = Grain uptake (kg ha^{-1} or g ha^{-1}) + Straw uptake (kg ha^{-1} or g ha^{-1})

Grain uptake (kg ha^{-1}) = Grain yield (q ha^{-1}) x Nutrient content (%) in grain

Straw uptake (kg ha^{-1}) = Straw yield (q ha^{-1}) x Nutrient content (%) in straw

Results

Effect on weed parameters

Density of Cyprus iria (m^{-2})

Among weed control treatments significantly highest density of Cyprus iria6.78, 6.80 & 7.02 m-2 at 30, 60 and 90 DAT respectively was found in weedy check. Among the herbicide at 30 DAT, lowest density of Cyprus iria weeds 2.25 m-2 found under Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha-1 PE fb 25g a.i ha-1 POE) was at par with Anilophos fb Bispyribac Sodium (400 g a.i ha-1 PE fb 25g a.i ha-1 POE) 2.58 m-2. At 60 DAT, the lowest density of Cyprus iria2.23 m-2 found in Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha-1 PE fb 25g a.i ha-1 POE) was at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha-1 PE fb 30 g a.i ha-1 POE). While at 90 DAT the lowest density of Cyprus iria 2.28 m-2 was found in Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha-1 PE fb 25g a.i ha-1 POE).

Nutrients studies

Nitrogen, phosphorus and potassium content in weeds (%)

The nitrogen, phosphorus and potassium content in weedranged from 1.18 to 0.93, 0.30 to 0.16 and 1.27 to 1.04% under different treatments. Nitrogen, phosphorus and potassium content were affected significantly by various treatments involving weed management practices. Among weed control treatments significantly highest nitrogen, phosphorus and potassium content 1.18, 0.30, & 1.27% respectively were found in weedy check. The lowest nitrogen, phosphorus and potassium contentat harvest 0.93, 0.16 & 1.04% respectively were found in two hand weeding. Among the herbicides lowest nitrogen content in weed at harvest stage found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1}POE) was at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE). The lowest phosphorus content in weeds at harvest stage found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1}POE) was at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE), Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1}PE fb25g a.i ha^{-1}POE), Anilophos fb Azimsulfuron (400 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE) and Azimsulfuron (30 g a.i ha^{-1}) fb one hand weeding and Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1}PE fb25g a.i ha^{-1}POE). The lowest potassium content at harvest stage found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1}POE).

Table 1: Effect of weed management practices on nutrient content (%) of weeds at 90 Days

Treatments		Nutrient content (%)		
		N	P	K
T_1	Weedy check	1.18	0.30	1.27
T_2	Two hand weeding (20 &40 DAT)	0.93	0.16	1.04
T_3	Butachlor (1.5 kg a.i ha^{-1}) fb One hand weeding	1.04	0.24	1.20
T_4	Pyrazosulfuron (150 g a.i ha^{-1} PE)	1.08	0.27	1.23
T_5	Azimsulfuron (30 g a.i ha^{-1} POE)	1.12	0.28	1.25
T_6	Oxidiargyl (100 g a.i ha^{-1} PE) fb one hand weeding	1.06	0.25	1.21
T_7	Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1}PE fb25g a.i ha^{-1} POE)	0.96	0.19	1.09
T_8	Pyrazosulfuron (150 g a.i ha^{-1}) fb one hand weeding	0.99	0.22	1.15
T_9	Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1} POE)	0.89	0.17	1.07
T_{10}	Anilophos fb Azimsulfuron (400 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE)	0.97	0.21	1.12
T_{11}	Azimsulfuron (30 g a.i ha^{-1}) fb one hand weeding	1.02	0.23	1.18
T_{12}	Pyrazosulfuronfb Azimsulfuron (150 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE)	0.94	0.18	1.08
	SEm±	0.05	0.009	0.003
	CD (P= 0.05)	0.14	0.02	0.009

Nitrogen, phosphorus and potassium uptake in weeds (kgha^{-1})

The nitrogen, phosphorus and potassium uptake in weed ranged from 19.74 to 3.09, 5.01 to 0.53 and 21.24 to 3.45 kgha^{-1} under different treatments. The data regarding the effect of different treatments on nitrogen, phosphorus and potassium uptake by weeds are presented in Table 2. Nitrogen, phosphorus and potassium were affected significantly with various treatments involving weed management practices. The highest Nitrogen uptake by weeds 19.74 kg $ha^{-1}$was found under weedy check while lowest 3.09 kg ha^{-1} in two hand weeding. Significantly highest phosphorus and potassium uptake 5.01 and 21.24 kg ha^{-1} respectively found in weedy check while the lowest phosphorus and potassium uptake 0.53 & 3.45 kg ha^{-1}respectively was found in two hand weeding. Among the herbicides lowest nitrogen, phosphorus and potassium uptake at harvest stage was found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1}POE) was at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE), Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1}PE fb25g a.i ha^{-1}POE) and Anilophos fb Azimsulfuron (400 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE).

Principal Component Analysis

The principal component analysis (PCA) was performed to ascertain the direct effect of different weed management treatments that most influenced panicle length, filled grains, unfiled garins, grain, straw and biological yield. The principal component analysis (PCA1 and PCA2) were responsible for 98.6 of the total variations (Fig 1)

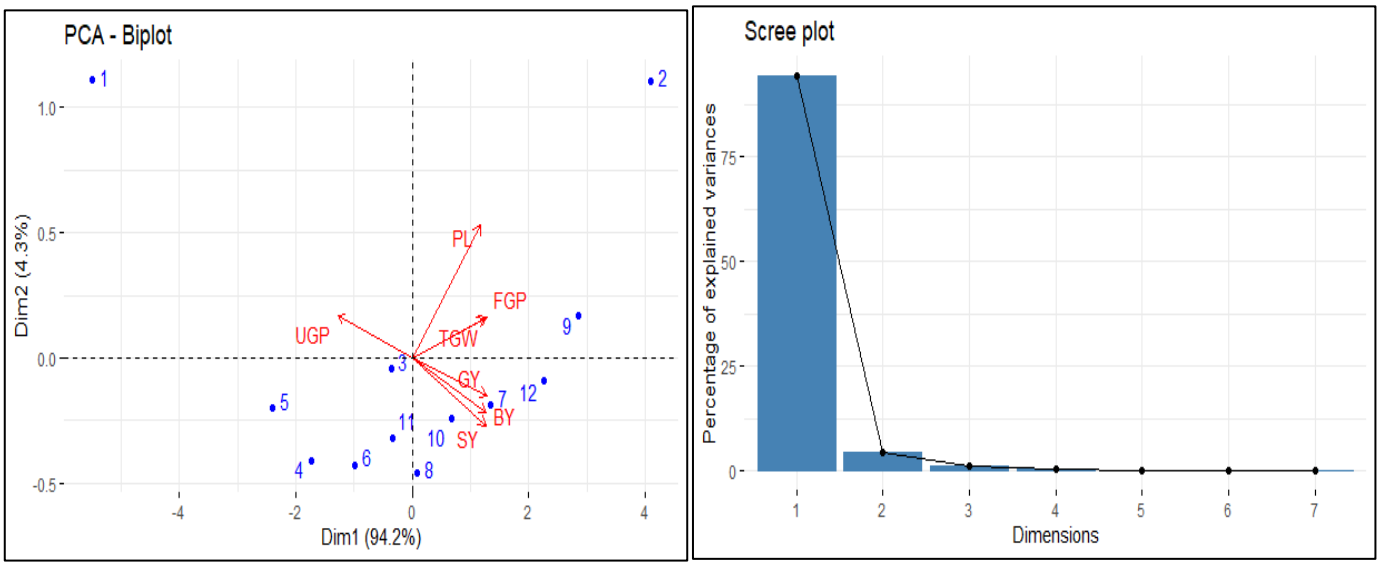

Fig 1: Principal Component Analysis

Table 2: Effect of weed management practices on nutrient uptake (kg ha^{-1}) by weeds in rice at 90 days

Treatments		Nutrient uptake (kg ha^{-1})		
		N	P	K
T_1	Weedy check	19.74	5.01	21.24
T_2	Two hand weeding (20 &40 DAT)	3.09	0.53	3.45
T_3	Butachlor (1.5 kg a.i ha^{-1}) fb One hand weeding	7.69	1.71	8.55
T_4	Pyrazosulfuron (150 g a.i ha^{-1} PE)	8.31	2.07	9.47
T_5	Azimsulfuron (30 g a.i ha^{-1} POE)	8.91	2.22	9.94
T_6	Oxidiargyl (100 g a.i ha^{-1} PE) fb one hand weeding	7.90	1.86	9.02
T_7	Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1}PE fb25g a.i ha^{-1} POE)	4.98	0.98	5.66
T_8	Pyrazosulfuron (150 g a.i ha^{-1}) fb one hand weeding	7.14	1.58	8.30
T_9	Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1}PE fb 25g a.i ha^{-1} POE)	3.72	0.71	4.48
T_{10}	Anilophos fb Azimsulfuron (400 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE)	5.27	1.14	6.09
T_{11}	Azimsulfuron (30 g a.i ha^{-1}) fb one hand weeding	7.44	1.67	8.61
T_{12}	Pyrazosulfuronfb Azimsulfuron (150 g a.i ha^{-1}PE fb 30 g a.i ha^{-1}POE)	4.63	0.88	5.32
	SEm±	0.54	0.21	0.56
	CD (P= 0.05)	1.55	0.61	1.62

Biological yield

The highest biological yield 119.70 q ha^{-1} found in two hand weeding was statistically at par with Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) and Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1} PE fb 30 g a.i ha^{-1} POE). Among the herbicides the highest biological yield 116.50 q ha^{-1} recorded with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) was at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1} PE fb 30g a.i ha^{-1} POE) 116.0 q ha^{-1} and significantly higher than the rest treatments. Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) recorded 34.93% higher biological yield over weedy check.

Harvest index

Weed control treatments the lowest harvest index 37.99% was found in weedy check while the highest harvest index 40.0% in two hand weeding. Among the herbicides the highest harvest index 39.65% recorded with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) was statistically at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1} PE fb 30 g a.i ha^{-1} POE), Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1} PE fb25g a.i ha^{-1} POE), Anilophos fb Azimsulfuron (400 g a.i ha^{-1} PE fb 30 g a.i ha^{-1} POE), Pyrazosulfuron (150 g a.i ha^{-1}) fb one hand weeding, Azimsulfuron (30 g a.i ha^{-1}) fb one hand weeding and Butachlor (1.5 kg a.i ha^{-1}) fb One hand weeding. Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) recorded 4.18% higher harvest index over weedy check.

Discussion

The different chemical controls the weeds effectively as compared to weedy check. Significantly the lowest total weed population under two hand weeding treatment because two hand weeding treatment was kept of weeds free by hand weeding. Highest total weed density and number of different weeds species were recorded in weedy check plots due to un checked growth of weeds which compete for all the resources up to maturity with crop. Two hand weeding plot proved to be the best treatment. Among the herbicides Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) found the best was at par with Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1} PE fb 30 g a.i ha^{-1} POE) to control weeds.

Among weed control treatments significantly highest nitrogen, phosphorus and potassium content in weeds 1.18, 0.30, & 1.27% respectively was found in weedy check. The lowest nitrogen, phosphorus and potassium content 0.93, 0.16 & 1.04% respectively at harvest was found in two hand weeding. Among the herbicides lower nitrogen, phosphorus and potassium content in weed at harvest stages was found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) was at par with Pyrazosulfuronfb Azimsulfuron (150 g a.i ha^{-1} PE fb 30 g a.i ha^{-1} POE), Anilophos fb Bispyribac Sodium (400 g a.i ha^{-1} PE fb25g a.i ha^{-1} POE) due to lowest depletion of nutrients was observed with Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE), due to minimum weed dry matter production in the treatment (Narwal *et al* 2002) [8] and higher depletion of N, P and K by weeds under weedy check condition. Kumar *et al* (2009) [7] also reported similar results.

Depletion of nutrients by weeds invariably resulted in reduced availability of nutrients to the crop and thus brought about marked reduction in crop growth and yield (Angiras *et al* 2005) [10]. Significantly more depletion of nutrients (N, P and K) was observed in weedy check as compared to all other treatments. Nitrogen, phosphorus and potassium uptake differ significantly with various treatments involving weed management practices. The highest N uptake by weeds 19.74 kg ha^{-1}was found under weedy check while lowest 3.09 kg ha^{-1} in two hand weeding. Significantly higher P and K uptake 5.01 and 2.24 kg ha^{-1}respectively by weeds was found in weedy check while the lowest phosphorus and potassium uptake 0.53 & 3.45 kg ha^{-1} respectively was found in two hand weeding. Among the herbicides lower nitrogen, phosphorus and potassium uptake at harvest was found with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE). However lowest depletion of nutrients was observed in Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE), due to minimum weed dry matter production in the treatment. (Nayak *et al* 2014) [9]; Yadav *et al* (2009**)** **[12]** also reported higher depletion of N, P and K by weeds under uncontrolled condition. The maximum dry matter accumulation were recorded under two hand weeding treatment at different growth stage during experimentation. Among herbicides treatment Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) was recorded the maximum plant height. This may be due to lower dry weight of weed in Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) applied plots followed by Pyrazosulfuron fb Azimsulfuron (150 g a.i ha^{-1} PE fb 30 g a.i ha^{-1} POE), which resulted in less crop-weed competition. Furthermore,

increased infestation of weeds showed negative influence on the crop growth as reflected in terms of lower initial plant height and plant biomass due to poor resource utilization (like nutrients uptake) at the critical period of crop-weed competition period *i.e.* 15-60 DAT. The possible reason of higher accumulation of dry matter of rice was the effect of herbicides on weeds so rice plant received more space, moisture, light and nutrient for their proper growth and this favored the higher dry matter accumulation of rice per unit area. The higher dry matter accumulation also associated with the higher height and number of tillers. The increasing foliage might have enhanced the photosynthesis due to which plant dry matter accumulation was higher under these treatments. This is in accordance with the findings of Khaliq (2013).Due to reduced crop-weed competition and better sink capacity performed more number of panicle^{-1}, filled grains, panicle length and test weight. The yield attributes are decided by genetic makeup of the crop and variety, but the agronomic manipulation also affects them to a great extent. The reproductive growth depends on vegetative growth of plant. More vegetative growth increases the photosynthetic area and supply of photosynthetic toward sink which decided the yield attributes and ultimately the yield. The higher values of yield attributes were due to increased synthesis and translocation of metabolites for the panicle development and grain formation. Similar results were noted by Bhowmick and Ghosh (2006) and Gogoi *et al.* (2005) [3] also confirmed the same.

Higher grain and biological yield was due to more accumulation of dry matter m^{-2} along with highest plant height, and number of tillers plant^{-1}. Treatment two hand weeding produced 2.11% higher biological over Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) due to better vegetative growth and more dry matter accumulation. The application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) was recorded.

Conclusion

Based on the results of experimentation, it seems that all weed control practices proved effective in controlling the weeds in transplanted rice and gave significantly higher biological yield over weedy. The application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) most effective control different weeds species very effectively resulted into higher value of weed control efficiency. Highest biological yield and lowest nutrient content and uptake of rice was noticed with the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE). Among weed management treatments Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) found excellent to control weed population and increase yield attributes and yield, Thus the application of Pyrazosulfuron fb Bispyribac Sodium (150 g a.i ha^{-1} PE fb 25g a.i ha^{-1} POE) found better for higher productivity and profitability of rice crop**.**

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