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Full Research Article

Effect of Plant Population and Weed Management Practices on Weed Dynamic and Crop Performance in Transplanted Basmati Rice (*Oryza sativa* L.)

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Abstract

A field experiment was carried out during summer seasons of 2009 and 2010 at CRC of SVPUA and T, Meerut India. Treatments comprising 4 planting geometries as main plot and 5 weed management in a split plot design with 3 replications by using F test. Experimental result revealed that plant population of 50 plants m^{-2} proved significantly superior over 20 plants m^{-2} in respect of weed density, weed dry weight at 90 DAT. Though, growth parameters viz., plant height, dry matter accumulation and No. of tillers m^{-2} at 90 DAT, grains weight $panicle^{-1}$, grain yield (29.00 and 31.00 q ha^{-1}), protein content, protein yield and N, P and K content in grain and straw were recorded with 50 plants m^{-2} followed by 40 plants m^{-2} during 2009 and 2010, respectively. As far as weed management practices was concerned, both chemical and mechanical methods of weed control were found significantly superior over weedy check in respect of lowest weed density and dry weight highest at 90 DAT although, significantly maximum growth parameters at 90 DAT, grains weight $panicle^{-1}$ grain yield of 30.40 and 32.60 q ha^{-1}, protein content, protein yield and N, P and K content in grain and straw were recorded with two hand weedings which was *on par* with Butachlor @ 1.0 kg a.i. ha^{-1} fb one hand weeding over rest of the weed management practices.

1. Introduction

Scented rice (*Oryza sativa* L.) cultivation is emerging as a new economic pursuit for the paddy farmers in some localities of Uttar Pradesh. Being a relatively recent introduction into Western Uttar Pradesh, adequate information on the population and weed management aspects of this crop are not locally available. Furthermore, weed competition is severe in scented paddy culture, in view of its early slow growth rates (Chander and Pandey, 2001) and it may be exacerbated by sub-optimal population densities. Maintenance of optimal population density is, therefore, critical for optimizing crop productivity. Moreover, rice cultivated on an area of 41.85 mha which is maximum among all rice growing countries having annual production about 89.13 mt and productivity of 2.1 t ha^1 (Anonymous, 2013).

Weeds are the cause of serious concern on yield reduction in rice production worldwide. Losses caused by weeds vary from one country to another country, depending on the predominant weed flora and on the control methods practiced by farmers. Two examples give an idea of the dimensions of the problem about 10 mt (Mt) of rice are lost annually due to weed competition (ZePu Zhang, 2001); such a quantity of rice is sufficient to feed at least 56 million people for 1 year. Weeds are the major biotic stress in rice production and account for 30 to 40% of yield losses (Abeysekera, 2001).Butachloris among the herbicides which have been tested worldwide for controlling weeds and improving the yield of rice (Rao et al., 2007; Farooq et al., 2011). Mechanical weed control and hoeing may also suppress the weeds and increase grain yield of rice (Rao et al., 2007). Weed count and weed dry weight was lowest in P3 (90-180×160) 2 rows skip after 2 rows planting as compared to other crop geometries (Sangle et al., 2007). Closer row spacing (15×15 cm^2) proved to be superior to wider row spacing (20×15 cm^2) with respect to total nutrient uptake (Gunari et al., 2004). The application of 1.0 kg Butachlor at 8 days after sowing (DAT)+one hand-weeding (HW) at 25 DAT and Butachlor+Almix @ 4 g a.i. ha^{-1} at 90 DAT found that all herbicides treatments decreased weed density and dry matter production (Kumar and Kumar, 2005). Moreover, *Echinochloa colona, Echinochloa crusgalli, Cyperus rotundus, Cyperus difformis* and *Ludwigia parviflora* were the major weeds. Almix+2, 4-DEE 15+500 g a.i. ha^{-1} applied at 8 DAT was found effective in controlling weeds. This was *on par* with hand weeding done thrice at 20, 40 and 60 days stage.

Plant height and total tiller were significantly higher in closer planted with twice hand weeding followed by Butachlor and Anilophos were *on par* with hand weeding as compared to other treatments (Rajkhowa et al., 2004). Whereas, normal planting with twice hand weeding which was significantly higher number of panicle weight m^{-2}, grain $panicle^{-1}$ and grain yield (Singh et al., 2006). However, under present investigation efforts were made to explore the feasibility of growing Basmati rice under different plant population. Therefore, the present study was carried out to investigate integrated effect of population and weed management regimes on weed dynamics, performance, *vis-a-vis* sustainability of Basmati rice.

2. Materials and Methods

The field experiment was conducted during summer seasons of 2009 and 2010 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.). Geographically the experimental site is located in semi-arid and sub-tropical region (29°05′ 19′′ N latitude, 77° 41′ 50′′ E longitudes) and at an elevation of 237 m amsl. The mean annual rainfall is about 862 mm, of which about 80−90% is received during a short span from July to September.

During first year, the mean minimum and maximum temperature varied in between 10.3 to 27.0 and 29.6 to 41.3 °C, respectively. Whereas, the respective values for second year were 30.2 to 41.8 and 13.8 to 27.3 °C. As far as total amount of rainfall is concerned, 329.4 and 423.6 mm rains were recorded during whole growth period of first and second year, respectively. The sunshine hours ranged from 1.8 to 9.3 hours in first year and 3.3 and 8.5 hours during second year. The crop received cumulative sunshine hours of about 141.9 hours during135 days of 2009 and 135.1 hours during 137 days of 2010. Soil samples from a depth of 0−15 cm were collected from each plot of the experiment prior to transplanting and a composite sample was drawn for determining its physical and chemical properties. The soil of experimental site was sandy loam in texture (57.6% sand, 25.6% silt and 16.8% clay), low in organic carbon (0.43 and 0.44%) and available nitrogen (158.7 and 160.4 kg ha^{-1}), high in available phosphorus (28.6 and 27.4 kg ha^{-1}) and medium in available potassium (125.3 and 126.6 kg ha^{-1}) with near to neutral (7.20 and 7.22 pH) in reaction. The twenty treatment combinations comprising of 4 planting geometries (20, 30.40 and 50 plants m^{-2}) and 5 weed management practices (Butachlor @ 1 kg a.i. ha^{-1}, Butachlor @ 1 kga.i. ha^{-1} fb one hand weeding, Butachlor @ 1 kg a.i.ha^{-1} fb Almix @ 4 g a.i. ha^{-1}, Two hand weeding, 20 and 40 DAT and Weedy check) were laid out in Split plot Design (S.P.D.). The herbicide was applied by using knap sap sprayer. The gross plot size was 20 m^{-2} and 60 cm buffer area was maintained between two plots within the replication, whereas the block border was 2 m. Keep planting geometries in main plots and weed management practices in sub plots with 3 replications. Transplanting was done manually as per treatments using two seedlings $plant^{-1}$. One week after transplanting, gap filling was done from the seedlings of same nursery for maintaining the optimum plant population. A uniform dose of 50 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} as basal through urea, single super phosphate and muriate of potash, respectively and rest of the 50 kg N/ha was top dressed at maximum tillering and panicle initiation in two equal splits through urea. Zinc sulphate was applied at 30 days stage through foliar spray @ 0.5% solution with two percent urea. The transplanting and harvesting was done on 14.07.2009 to 15.07.2010 and 04.11.2009 to 05.11.2010 during first and second year, respectively. The density and dry weight of weeds were recorded at 90 days after transplanting, yields attributes and yield at harvest of the crop. Analysis of plant sample at harvest was carried out for their nitrogen, phosphorus and potassium contents by adopting the standard procedures as described by Jackson (1973) and protein yield was computed as per described by AOAC (1960). The data recorded on different observations were tabulated and analyzed statistically by using the analysis of variance (ANOVA) techniques as suggested by Gomez and Gomez (1984).

3. Results and Discussion

3.1. Weed dynamics at 90 DAT

The mean data presented in Table 1 and Table 2 revealed that the weed densities and their weed dry weight varied significantly due to planting geometries and weed management practices. Each successive increment in planting geometries upto 50 plants m^2 significantly decreased the number of weeds unit $area^{-1}$ and their weed dry weight respectively. The *Echinochloa crusgalli* (L), *Cyperus rotundus* (L) *Eclipta alba and* other weeds densitiesas well as their weed dry weight increased. 50 plants m^{-2} recorded significantly minimum *Echinochloa crusgalli* (L), *Cyperus rotundus* (L), *Eclipta alba* and other weeds density (19.2 and 20.2%, 19.0 and 19.7%, 17.0 and 15.8% and 19.1 and 20.1%, respectively) and their weed dry weight (18.2 and 18.1%, 17.4 and 18.6%, 13.0 and 11.2% and 17.8% and 17.7%, respectively) as compared to 20 plants m^2 followed by 40 plants m^2 and 30 plants m^2 during both the years. This suppress the weed population and retard the total weed dry weight due to lesser availability of space, moisture, light, CO_2 and nutrients.

Table 1: Effect of plant population and weed management practices on Weed density at 90 DAT of Basmati rice

Treatment	Weed dry weight (g m^2) at 90 DAT							
	Echinochloa crusgalli		*Cyperus rotundus*		*Eclipta alba*		Other weeds	
	2009	2010	2009	2010	2009	2010	2009	2010
Plant population								
20 plants m^{-2}	4.47 (19.50)	4.45 (19.10)	4.10 (16.20)	3.96 (15.20)	2.70 (6.50)	2.66 (6.26)	4.34 (18.40)	4.28 (17.87)
30 plants m^{-2}	4.21(17.40)	4.13(16.80)	3.86 (14.50)	3.68 (13.10)	2.56 (5.78)	2.48 (5.36)	4.10 (16.36)	3.97 (15.40)
40 plants m^{-2}	4.32 (20.40)	3.86 (14.50)	3.62 (12.60)	3.44 (11.30)	2.42 (5.04)	2.34 (4.66)	3.83 (14.26)	3.71(13.32)
50 plants m^{-2}	3.61(12.80)	3.55 (12.40)	3.32 (10.60)	3.18 (9.70)	2.24 (4.26)	2.18 (4.60)	3.51 (12.04)	3.42 (11.42)
SEm±	0.20	0.03	0.02	0.01	0.03	0.03	0.01	0.01
CD (*p*=0.05)	0.50	0.08	0.05	0.03	0.09	0.09	0.03	0.03
Weed management practices								
Butachlor @ 1 kg ha^{-1}	4.42 (18.60)	4.37 (18.30)	4.06 (15.60)	3.89 (14.30)	2.68 (6.22)	2.61(5.85)	4.31 (17.63)	4.21 (16.80)
Butachlor @ 1 kg a.i. ha^{-1} fb 1 HW	3.31 (10.00)	3.23 (9.60)	3.02 (8.20)	2.89 (7.50)	2.06 (3.30)	2.01 (3.10)	3.20 (9.35)	3.10 (8.75)
Butachlor @ 1 kg a.i. ha^{-1} fb Almix	4.65 (23.20)	4.13 (16.20)	3.82 (13.70)	3.68 (12.60)	2.54 (5.50)	2.48 (5.18)	4.05 (15.53)	3.97 (14.85)
Two hand weedings	3.11 (8.80)	3.02 (8.20)	2.87 (7.30)	2.69 (6.40)	1.97 (2.93)	1.89 (2.63)	3.03 (8.30)	2.90 (7.53)
Weedy check	5.30 (27.10)	5.26 (26.80)	4.84 (22.60)	4.67 (21.00)	3.16 (9.03)	3.10 (8.60)	5.14 (25.50)	5.05 (24.60)
SEm±	0.20	0.03	0.03	0.02	0.04	0.03	0.02	0.02
CD (*p*=0.05)	0.60	0.08	0.08	0.05	0.11	0.09	0.05	0.06

Data subjected to square root transformation (X+1); Value in parentheses are original

The effect of different weed management practices on *Echinochloa crusgalli* (L), *Cyperus rotundus* (L) *Eclipta alba and* other weeds density and their weed dry weight was significant. Moreover, two hand weedings at 90 DAT was found most effective in reducing *Echinochloa crusgalli* (L), *Cyperus rotundus* (L) *Eclipta alba* and other weeds as well as their weed dry weight as compared to rest of the weed management practices. The application of Butachlor @ 1.0 kg a.i. ha^{-1} fb one hand weeding was also found effective in reducing the *Echinochloa crusgalli* (L), *Cyperus rotundus* (L) *Eclipta alba* and other weeds density even their weed dry weight at every observational date. This may be due to effective suppression of weed as the weeds germination inhibited by pre-emergence application of Butachlore herbicide followed by its integration with second hand weedings at later stages of crop removed the weeds successfully at 90 DAT. The similar findings were also reported by (Singh et al., 2005; Ramana et al., 2007).

3.2. Growth parameters at 90 DAT

The data presented in Table 3 claimed that each increment in plant population from 20 plants m^{-2} to 50 plants m^{-2} resulted in significant increase plant height, dry matter accumulation and number of tillers during both the years. The highest planting geometry of 50 plant m^{-2} produced tallest plant height (112.8 and 118.3 cm), maximum dry matter accumulation (797.0 and 804.3 gm m^{-2}) and more number of tillers (268.6 and 261.2) during both the years as compared to rest of the treatment. However, the magnitudes were higher during second year, except number of tillers. Whereas, the minimum plant height, dry matter accumulation and number of tiller were found with 20 plants m^{-2} during 2009 and 2010. However, the magnitudes were higher during second year. This might be due to the more competition for interception and utilization of solar light in closer spacing in comparison to wider spacing for plant height, dry matter accumulation. Furthermore, as far as the tillers production plant^{-1} concern, it clearly indicate that total tillers production plant^{-1} increased with increase in row spacing but increase in tillers production failed to meet out total tillers m^{-2} due to reduction in plant population plant^{-1} consequently trapped more light, space, water, nutrients and CO_2 resulting in high photosynthetic rate produced unit area^{-1}. These findings

Table 2: Effect of plant population and weed management practices on Weed dry weight at 90 DAT of Basmati rice

Treatment	Weed dry weight (g m^{-2}) at 90 DAT							
	Echinochloa crusgalli		*Cyperus rotundus*		*Eclipta alba*		Other weeds	
	2009	2010	2009	2010	2009	2010	2009	2010
Plant population								
20 plants m^{-2}	2.86 (7.52)	2.81 (7.30)	2.64 (6.30)	2.53 (5.70)	1.84 (2.50)	2.14 (3.70)	2.81 (7.10)	2.60 (6.00)
30 plants m^{-2}	2.71 (6.64)	2.66 (6.38)	2.50 (5.52)	2.40 (5.02)	1.76 (2.20)	2.10 (3.40)	2.64 (6.30)	2.41 (5.10)
40 plants m^{-2}	2.56 (5.78)	2.51 (5.51)	2.37 (4.82)	2.26 (4.31)	1.70 (1.90)	1.98 (3.10)	2.51 (5.40)	2.24 (4.10)
50 plants m^{-2}	2.34 (4.64)	2.30 (4.36)	2.18 (3.88)	2.06 (3.40)	1.60 (1.50)	1.90 (2.70)	2.31 (4.30)	2.14 (3.80)
SEm±	0.02	0.01	0.02	0.02	0.02	0.02	0.01	0.02
CD (p = 0.05)	0.05	0.03	0.06	0.06	0.06	0.06	0.03	0.08
Weed management practices								
Butachlor @ 1 kg ha^{-1}	2.89 (7.45)	2.81 (7.21)	2.66 (6.15)	2.57 (5.65)	2.55 (2.50)	2.04 (3.20)	2.82 (7.00)	2.60 (5.80)
Butachlor @ 1 kg a.i. ha^{-1} fb 1 HW	2.17 (3.73)	2.12 (3.53)	2.02 (3.11)	1.93 (2.73)	1.50 (1.20)	1.80 (2.20)	2.11 (3.50)	1.88 (2.60)
Butachlor @ 1 kg a.i. ha^{-1} fb Almix	2.63 (6.03)	2.57 (5.63)	2.13 (5.01)	2.32 (4.40)	1.71 (2.00)	1.91 (2.70)	2.56 (5.60)	2.43 (4.60)
Two hand weedings	2.01 (3.10)	1.94 (2.81)	1.88 (2.55)	1.77 (2.21)	1.42 (1.00)	1.72 (2.00)	1.96 (2.90)	1.77 (2.20)
Weedy check	3.38 (10.55)	3.33(10.23)	3.12 (8.85)	2.98 (8.03)	2.11 (3.50)	2.67 (6.10)	3.30(10.00)	3.06 (8.50)
SEm±	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03
CD (p=0.05)	0.06	0.09	0.08	0.09	0.08	0.09	0.06	0.09

*Data subjected to square root transformation; Value in parentheses are original

were in conformity with the results of (Geethadevi et al., 2000) and (Gobi et al., 2006).

Further scrutiny of the result indicated that both mechanical and chemical methods of weed control were found superior over weedy cheek in respect of growth parameters. Although, maximum plant height (112.6 and 119.0 cm), dry matter accumulation (819.0 and 825.5 gm m^{-2}) and number of tiller (262.6 and 257.2) were recorded with two hand weedings. However, the magnitudes were higher during second year. While, loweredgrowth values were recorded with weedy cheek during both the years. This might be due to the more competition with weeds for interception and utilization of light, water, nutrients and CO_2 in closer spacing in comparison to wider spacing. The similar opinions were also made by (Sharanappa et al., 1994).

3.3. Grains weight panicle^{-1}

Plant population and weed management practices had statistically not significant in the context of grain yield penicle^{1} (Table 3). Although, the maximum grains weight panicle^{-1} was recorded with 50 plants m^{-2} followed by 40 plants m^{-2}, while the minimum grains weight panicle^{-1} was recorded with 20 plants m^{-2} during both the years. The weed management practices had significant effect on grains weight panicle^{-1} during both the years of experimentation. The highest grains weight panicle^{-1} was recorded with two hand weedings followed by Butachlor @ 1.0 kg a.i. ha^{-1} fb one hand weeding, while the lowest grains weight panicle^{-1} was recorded with weedy check during both the years. However, the magnitudes were higher during second year.

3.4. Grain yield (q ha^{-1})

Successive increase in plant population resulted in significant increase in the grain yield of 50 plant m^{-2} during both the years (Table 3). Moreover, 50 plants m^{-2} produced maximum grain yieldof 2.90 t ha^{-1} during 2009 and 3.10 t ha^{-1} during 2010 and remained statistically *on par* with 40 plants m^{-2}, during both years. There was a reduction in grain yield (33.03%, 16.93% and 5.07%) and (31.35%, 15.67% and 4.03%) with 50 plant m^{-2} over the 20 plant m^{-2}, 30 plant m^{-2} and 40 plants m^{-2} treatments during 2009 and 2010, respectively. The increase in grain yield was mainly due to more accumulation of photosynthates and their translocation towards sink which inturn led to better development of yield attributes at wider planting. These results are in accordance with the findings of (Kumar et al., 2005).

Further scrutiny of the results indicating that both mechanical and chemical methods of weed control were found superior over weedy cheek. The maximum grain yield (3.04 and 3.26 t ha^{-1}) was recorded with two hand weedings, which remained statistically *on par* with Butachlor @ 1.0 kg a.i. ha^{-1} fb one

Table 3: Effect of plant population and weed management practices on growth parameters at 90 DAT, grains weight panicle^{-1}, grain yield, protein content and protein yield of Basmati rice

Treatment	Plant height (cm)		Dry matter accumulation (g m^{-2})		Number of tillers m^{-2}		Grains-weight panicle^{-1}		Grain yield (t ha^{-1})		Protein content (%)		Protein yield (kg ha^{-1})	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Plant population														
20 plants m^{-2}	104.4	111.0	608.4	614.2	136.0	137.7	2.11	2.15	2.18	2.36	7.10	7.20	154.78	169.92
30 plants m^{-2}	107.2	113.5	775.9	731.5	224.5	213.9	2.16	2.20	2.48	2.68	7.20	7.30	178.56	195.64
40 plants m^{-2}	110.7	115.4	765.6	771.1	239.2	243.0	2.25	2.26	2.76	2.98	7.20	7.30	198.72	217.54
50 plants m^{-2}	112.8	118.3	797.0	804.3	268.6	261.2	2.27	2.28	2.90	3.10	7.30	7.30	211.70	226.30
SEm±	0.33	0.66	4.0	4.5	3.85	3.78	0.10	0.11	0.05	0.05	0.01	0.02	-	-
CD (p=0.05)	0.99	1.90	12.0	13.0	11.1	11.34	NS	NS	0.16	0.17	0.03	0.05	-	-
Weed management practices														
Butachlor @ 1 kg a.i ha^{-1}	106.9	111.8	701.7	708.1	218.8	221.7	2.15	2.19	2.47	2.69	7.22	7.25	178.33	195.03
Butachlor @ 1 kg a.i. ha^{-1} fb 1 HW	110.8	118.8	805.7	812.2	245.8	248.3	2.23	2.25	2.97	3.18	7.30	7.30	216.81	232.14
Butachlor @ 1 kg a.i. ha^{-1} fbAlmix	108.8	114.1	768.1	774.2	231.0	225.4	2.18	2.28	2.63	2.88	7.22	7.20	189.89	207.36
Two hand weedings	112.6	119.0	819.0	825.5	262.6	257.2	2.30	2.31	3.04	3.26	7.30	7.35	221.92	239.61
Weedy check	104.8	109.1	526.8	531.4	127.3	130.3	2.12	2.17	1.91	1.99	7.18	7.15	137.14	142.29
SEm±	0.34	0.79	4.1	4.7	4.17	3.50	0.11	0.12	0.05	0.05	0.02	0.02	-	-
CD (p=0.05)	1.00	2.26	12.3	13.5	12.03	10.08	NS	NS	0.14	0.13	0.05	0.06	-	-

hand weeding, while the minimum grains yield was recorded with weedy cheek during both the years. There was a reduction in grain yield by 23.07%, 2.36%, 15.58% and 59.16% and 21.18%, 2.51%, 13.19% and 63.81% compared with two hand weedings with Butachlor @ 1.0 Kg a.i. ha^{-1} fb one hand weeding over the Butachlor @1.0 kg ha^{-1}, Butachlor @ 1.0 kg a.i. ha^{-1} fbAlmix @ 4 g a.i. ha^{-1} and weedy check during 2009 and 2010, respectively. This might be due to effective control of weeds in the early stages as well as later stage of crop growth, besides better utilization of the resources by the crop, minimal competition with weeds and maintenance of lower weed population throughout the crop growth period. These findings are also supported by (Kalyanasundaram et al., 2006).

3.5. Significant interaction on grain yield

Crop grown under 50 plants m^{-2} with two hand weedings (Table 4) maintained an average grain yield (3.59 t ha^{-1}) were significantly higher than other treatments combination. Moreover, among chemical treatments which was *on par* with 50 plants m^{-2}+Butachlor @ 1.0 kg a.i. ha^{-1} fb one hand weeding (3.35 t ha^{-1}), during both the years.

3.6. Quality parameters

The plant population of 50 plants m^{-2} registered significantly higher protein content (7.30 and 7.30%) and computable protein uptake (211.7 and 226.30 kg ha^{-1}) (Table 3), which was almost statistically alike with 40 plants and 30 plants m^{-2},

Table 4: Interaction effect of plant population and weed management on grain yield (t ha^{-1}) of Basmati rice (pooled over 2 years)

Weed management practices	Plant population			
	20 plants m^{-2}	30 plants m^{-2}	40 plants m^{-2}	50 plants m^{-2}
Butachlor @ 1 kg a.i ha^{-1}	2.00	2.50	2.72	3.10
Butachlor @ 1 kg a.i. ha^{-1} fb 1 HW	2.48	2.94	3.08	3.34
Butachlor @ 1 kg a.i. ha^{-1} fb Almix	2.61	2.73	2.77	2.88
Two hand weedings	2.73	2.99	3.39	3.59
Weedy check	1.52	2.00	2.10	2.17
SEm±	0.09			
CD (p=0.05)	0.26			

then 20 plants m^{-2} during 2009 and 2010, respectively. Higher protein content in grains was might be due to the more nitrogen content in grains (Table 5) and higher grain yield which inturn improved the protein yield.

The weed management practices had also significant effect on protein content in grain during both the years. The significantly lowest protein content in grain was obtained with weedy check and the maximum protein content (7.30 and 7.35%) and computable protein uptake (221.92 and 239.61 kg ha^{-1}) was recorded with two hand weedings which was *on par* with Butachlor @ 1.0 kg a.i. ha^{-1} fb one hand weeding during both the years. Although, an interaction effect of plant population and weed management practices was found non-significant during both the years.

3.7. Nutrients content

The datarely under Table 5 reveals that N, P and K content in grain and straw were significantly affected with plant population of 50 plants m^{-2} during both the years of experimentation, except N content in grain, which was not significant even lowered in 50 plants m^{-2} (1.26% in 2009 and 2010 of each). However, nitrogen content in straw was recorded maximum in 50 plants m^{-2} over 40, 30 and 20 plants m^{-2} during both the years. This might be due to the fact that the closer plant geometry could have exploited higher amount of fertilizer nutrients and thus, increased the nitrogen content in grains and straw. Similar results also reported by (Pal et al., 2005). The P and K content in grains (0.368 and 0.359% and 0.302 and 0.292%) and straw (0.174 and 0.164% and 1.410 and 1.390%) with 50 plants m^{-2} was significantly superior over rest of treatments except 40 plants m^{-2}, while the lowest phosphorus content was recorded with 20 plants m^{-2} during 2009 and 2010, respectively.

The nitrogen content in grains did not influenced by weed management practices during both the years. However, nitrogen content in straw was recorded significantly maximum in two hand weedings (0.51 and 0.51%) followed by Butachlor @ 1.0 kg a.i. ha^{-1} fb one hand weeding during both the years (Table 5). Significantly maximum P content in grain (0.365 and 0.359%) was found with two hand weedings. Whereas, in straw (0.163 and 0.155%) was recorded maximum under Butachlor @ 1.0 kg a.i. ha^{-1} during 2009 and 2010, respectively. Although, highest K content in grain (0.265 and 0.255%) as well as in straw (1.343 and 1.333%) was noticed significantly with two hand weedings during 2009 and 2010, respectively.

Table 5: Effect of plant population and weed management practices on nutrients content of Basmati rice

Treatment	Nitrogen content				Phosphorus content				Potassium content			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Plant population												
20 plants m^{-2}	1.29	1.28	0.40	0.30	0.336	0.330	0.140	0.130	0.208	0.198	1.258	1.248
30 plants m^{-2}	1.28	1.27	0.40	0.40	0.338	0.329	0.157	0.146	0.229	0.218	1.365	1.354
40 plants m^{-2}	1.27	1.27	0.50	0.50	0.366	0.357	0.167	0.159	0.253	0.244	1.267	1.256
50 plants m^{-2}	1.26	1.26	0.60	0.61	0.368	0.359	0.174	0.164	0.302	0.292	1.410	1.390
SEm±	0.01	0.01	0.01	0.01	0.002	0.004	0.002	0.001	0.003	0.002	0.004	0.003
CD (p=0.05)	NS	NS	0.03	0.03	0.005	0.011	0.006	0.003	0.008	0.005	0.011	0.009
Weed management practices												
Butachlor @ 1 kg a.i ha^{-1}	1.27	1.27	0.40	0.40	0.358	0.348	0.163	0.155	0.238	0.228	1.314	1.303
Butachlor @ 1 kg a.i. ha^{-1} fb 1 HW	1.26	1.26	0.50	0.48	0.350	0.343	0.163	0.153	0.253	0.243	1.334	1.328
Butachlor @ 1 kg a.i. ha^{-1} fb Almix	1.27	1.25	0.50	0.46	0.353	0.340	0.158	0.148	0.253	0.243	1.328	1.315
Two hand weedings	1.26	1.26	0.51	0.52	0.365	0.359	0.162	0.146	0.265	0.255	1.343	1.333
Weedy check	1.27	1.25	0.40	0.40	0.335	0.327	0.153	0.141	0.232	0.223	1.300	1.290
SEm±	0.01	0.02	0.01	0.01	0.006	0.008	0.001	0.003	0.004	0.004	0.010	0.004
CD (p=0.05)	NS	NS	0.03	0.03	0.018	0.023	0.003	0.009	0.011	0.012	0.030	0.011

However, minimum N, P and K content in grain and straw were significantlyrecorded with weedy check during both the years. This might be due to the fact that dry matter increased in terms of grain and straw yields and better weed control. These findings confirm the results of (Chaubey et al., 1999).

4. Conclusion

Adoption of 50 plants m^{-2} along with the application of Butachlor @ 1.0 kg a.i. ha^{-1} fb one hand weeding was found best agronomic packageof practice to ensured produce qualities and maximized grain yield by reducing the weed density and grain sterility, besides significant effect on nutrient content.

5. References

A.O.A.C., 1960. Methods of Analysis. Association of Official agricultural Chemists, Washington, D.C. 9th edition, 15−16.

Abeysekera & Anuruddhika, S.K., 2001. Management of *Echinochloa* spp. in rice in Sri Lanka. Paper presented at the FAO workshop on *Echinochloa* spp. control, Beijing, China, 13.

Anonymous, 2013−14. Agricultural statistics at a glance, Ministry of Agriculture, 46−53. Available from www.cimmet.nic.in. Accessed on March 1, 2014.

Chander, S., Pandey, J., 2001. Effect of rice culture, nitrogen and weed control on nitrogen competition between scented rice and weeds. Indian Journal of Agronomy, 46, 68−74.

Choubey, N.K., Tripathi, R.S., Ghosh, B.C., 1999. Effect of fertilizer and weed management on direct-seeded rice on nutrient utilization. Indian Journal of Agronomy 44(2), 213−215.

Farooq, M., Kadambot, Siddique H.M., Rehman, H., Aziz, T., Lee, D., Wahid, A., 2011. Rice direct seeding: Experiences, challenges and opportunities. Soil and Tillage Research 111, 87−98.

Geethadevi, T., Andani, G., Krishnappa, M., Babu, B.T.R., 2000. Effect of nitrogen and spacing on growth and yield of hybrid rice. Current Research University Agricultural Science 29(516), 73−75.

Gobi, R., Ramesh, S., Pandian, B.J., Chandrasekaran, B., Sampathkumar, T., 2006. Evaluation of crop establishments and split application of N and K on growth, yield attributes, yield and economics of hybrid rice CoRH2. Asian Journal of Plant Sciences 5(6), 1022−1026.

Gomez, K.A., Gomes, A.A.,1984. Statistical procedures for Agricultural Research. Pb. John Wiley and Sons, 2nd edn., New York.

Gunari, S.K., Pal, S.K., Choudhury, A., 2004. Effect of integrated nitrogen application and spacing on yield of rice (*Oryza sativa*) in foot-hill soils of West Bengal.Indian Journal of Agronomy 49(4), 248−250.

Jackson, M.L., 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi.

Kalyanasundaram, D., Kumar, K.P.S., 2006. Studies on Integrated weed management in direct seeded wetland rice.Research on Crops. 7(3), 627−629.

Kumar, G.P., Kumar, U., 2005. Effect of sequential application of pre and post emergence herbicides in wet seeded rice. Crop Research Hisar 29(3), 366−370.

Pal, S.K., Chowdhury, A., Gunari, S.K., 2005. Effect of integrated nitrogen management and plant density on yield and nitrogen balance of rice under lowland situation. *Oryza* 42(1), 41−47.

Rajkhowa, D.J., Barua, I.C., Gogoi, A.K., 2004. Effect of planting methods and weed management on transplanted summer rice. Indian Journal of Weed Science 36(3), 111−115.

Ramana, A.V., Naidu, G.J., Ramanamurthy, K.V., 2007. Integrated weed management in rainfed upland rice (*Oryza Sativa* L.). Indian Journal of Agronomy 52(4), 311−314.

Rao, A.N., Johnson, D.E., Sivaprasad, B., Ladha, J.K., Mortimer, A.M., (2007) Weed Management in Direct-Seeded Rice. Advance in Agronomy 93, 153−255.

Sangle, B.B., Patil, H.M., Khairur, A.V., Wani, A.G., 2007. Effect of crop geometric and weed control treatment on yield and quality parameter of irrigated cotton (*Gossypium hirsutum*) Journal of farming system, Research and Development 13(2) 260 – 262.

Sharanappa, Munegowda, M.K., Maharudrappa, K., 1994. Efficacy of herbicides on weed management in drill sown rice. Mysore Journal of Agricultural Science 18(10), 8−13.

Singh, U.P., Yashwant, Singh, Prasad, Kamta, 2006. Effect of planting pattern and weed control on Boro Rice. Indian Journal of weed science 38(1 & 2), 42−44.

Singh, R.G., Singh, O.P., Kumar, T., Mehta, R.K., Kumar, V., Singh, P.P., 2005. Effect of weed management practices on direct-seeded rice under puddled lowlands. Indian Journal of Agronomy 50(1), 35−37.

ZePu Zhang., 2001. Weed management in rice in China. Summary presented at FAO Workshop on *Echinochloa* spp. Control, Beijing, China, 27 May.