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Residual effect of integrated weed and nutrient management on the growth and yield of zero tilled rapeseed in rice-rice-rapeseed cropping system

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Abstract
A field experiment was conducted during the pre-kharif, kharif and rabi season of 2017-18 and 2018-19 in the Research Farm of College of Agriculture, Central Agriculture University, Imphal in entitled, "to study the residual effect of integrated weed and nutrient management on the growth and yield of zero tilled rapeseed in rice-rice-rapeseed cropping system". The experiment was laid out in split plot design with replicated thrice. The treatments comprised with five weed management practices in the main plot *viz*., (W_1) pre-emergence Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i ha^{-1}, (W_2) post-emergence Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i ha^{-1}, (W_3) pre-emergence Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i ha^{-1} + post-emergence Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i ha^{-1}, (W_4) 2 Hand weeding at 25 & 45 DAS and (W_5) Weedy check and four nutrient management in the sub plot *viz*., (N_1) 100% RDF Nitrogen as urea, (N_2) 75% RDF Nitrogen as urea + 25% RDF Nitrogen as Loktakphumdi compost, (N_3) 50% RDF Nitrogen as urea + 50% RDF Nitrogen as Loktakphumdi compost and (N_4) 100% RDF Nitrogen as Loktakphumdi compost. The pooled data revealed that among the weed management practices, application of pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS (W_3) in preceding *kharif* rice gave the highest growth and yield attributes of rapeseed. Among the nutrient management practices, highest growth and yield of rapeseed were obtained in the application of 75% RDF nitrogen as urea + 25% RDF nitrogen as loktakphumdi compost (N_2). The interaction between the integrated weed and nutrient management practices had significantly effect on the growth and yield attributes.

Keywords: Integrated weed management, integrated nutrient management, rapeseed, Loktakphumdi compost and cropping system

Introduction
Rapeseed mustard is the third important oilseed crop as edible vegetable oil, after soybean and palm oil with global production of rapeseed oil of about 12-14 million tonnes. India ranks third in rapeseed-mustard production after China and Canada and fourth largest oilseed economy in the world sharing 27.8% in oilseed economy of India. In India, over 65% of the total vegetable oil produced is derived from soybean and rapeseed-mustard. A whopping production of 74.37 lakh tonnes of oilseeds and 23.05 lakh tonnes of oil was recorded in India (2012-2013). In Manipur after rice harvest, the land is kept fallow without any crop by most of the farmers which otherwise has huge potential for growing a second crop in the Rabi season with the residual moisture and additional one or two lifesaving irrigations. Rapeseed-Mustard is one of the most important choices to the farmers of Manipur which not only increase their income but also utilizes the residual moisture and nutrients present in soil. The productivity of yellow mustard in rice-yellow mustard system is far below than its potential yield due to many constraints. The major contributory causes are delayed sowing due to late harvesting of preceding long duration rice varieties and soil wetness and moisture stress at critical stage of the crop growth resulting in reduced yield (Duary *et al.* 2016a) [3]. Rabi season in eastern India is characterized with short and mild winter. Proper utilization of short and mild winter is one of the major challenges for the cultivation of Rabi crops. Time of sowing is an important non-monetary input for obtaining higher yield in rapeseed-mustard. In the lateritic belt of West Bengal, the optimum time of sowing of the crop is last week of October to the second fortnight of November (Duary *et al.* 2016b) [4].

Late transplanting and delayed harvesting of rice usually result in late sowing of succeeding rapeseed-mustard when raised under conventional method of sowing which in turn reduces the yield significantly. However, this yield reduction can be minimized through manipulation of tillage operations enabling early sowing of rapeseed-mustard by adopting reduced tillage systems. Zero tillage can advance the sowing time through a single tractor operation using a specially designed seed-cum-fertilizer drill. However, Zero tillage practices are more advantageous when crop residues are retained on the soil surface, which serves as physical barrier towards emergence of weeds, moderate soil temperature, conserve soil moisture add organic matter and solve the problem of air pollution arising due to large-scale burning of straw residues (Sharma *et al.* 2012) [17]. Season long weed management in kharif rice may also provide effective weed control for succeeding crop in winter seasons. The herbicides applied in preceding crop might show prolonged persistence in soil resulting in reduced weed infestation in succeeding crops in the system. However, sometimes undesirable herbicide residues may affect the growth and productivity of succeeding crop. (Janki *et al*. 2015) [6]. The production management are now practiced globally on about 157 M ha (Kassam *et al*. 2015) [9]. In India, over the past few years, the adoption of Zero tillage has expanded to cover about 1.5 million hectares (Jat *et al.* 2014) [7]. Keeping this in view, a field experiment was carried out to study the effect of residual effect of integrated weed and nutrient management on the growth and yield of zero tilled rapeseed in rice-rice-rapeseed cropping system.

Materials and methods

A field experiment was conducted during pre-kharif, kharif and rabi season of 2017 and 2018 at the Agriculture Research Farm, Department of Agronomy, College of Agriculture, Central Agriculture University, Imphal. The soil of experimental site was clay soil in texture and medium in fertility with good drainage facility having pH 5.4, available organic carbon 1.4%, available nitrogen 310.03 kg ha^{-1}, available phosphorus 20.78 kg ha^{-1} and available potassium 248.12 kg ha^{-1}. The experiment was laid out in split plot design with three replications. The treatments given in the preceding *kharif* rice comprised of five weed management subjected to main plots while four nutrient management in sub plots. A combination of 60 treatments consisting of five weed management practices, *viz*., (W_1) pre-emergence Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i ha^{-1}, (W_2) post-emergence Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i ha^{-1}, (W_3) pre-emergence Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i ha^{-1} + post-emergence Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i ha^{-1}, (W_4) 2 Hand weeding at 25 & 45 DAS and (W_5) Weedy check and four nutrient management, *viz*., (N_1) 100% RDF Nitrogen as urea, (N_2) 75% RDF Nitrogen as urea + 25% RDF Nitrogen as Loktakphumdi compost, (N_3) 50% RDF Nitrogen as urea + 50% RDF Nitrogen as Loktakphumdi compost and (N_4) 100% RDF Nitrogen as Loktakphumdi compost. The rapeseed variety used in the experiment was yellow sarson hissar-401. For recommended dose of fertilizer half dose of nitrogen was applied through urea, full dose of phosphorus through SSP and potassium through MOP were applied before sowing as basal application. The remaining 50% Nitrogen was applied at flowering initiation stage. Rapeseed seeds were sown in lines with 20 cm row to row distance between the rows of stubbles left by previous rice crop with a plant to plant distance of 5 cm. The seed rate was 12 kg ha^{-1} and sowing was done in the last week of November. Growth parameters were recorded at 25 days interval and yield was recorded at the time of harvest. All data obtained were subjected to statistical analysis by the analysis of variance (ANOVA) and significant differences between the means were determined using Split plot design at 5% probability level. (Gomez and Gomoz, 1976) [5].

Result and discussion

Residual effect of integrated weed and nutrient management on growth attributes of rapeseed

Different integrated weed and nutrient management practices had significantly residual effect on the growth attributes of rapeseed as evident from the pooled data in Table 1. Among the different weed management practices, maximum plant height was recorded in the application of pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS i.e. (W_3) with the height of (69.97 cm). Similarly, highest number of branches $plant^{-1}$ was recorded with the application of pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS i.e. (W_3) with a value of (4.42) but with no significant difference between them i.e. post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS, pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS and two hand weeding at 25 and 45 DAS (W_2, W_1 and W_4) value of (4.20, 4.09 and 3.83) in Table 2. Maximum dry matter accumulation and crop growth rate were observed with the application of pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS i.e. (W_3) with (284.04 g m^{-2} and 3.52 g m^{-2} day^{-1}) but no significant difference between them. The lowest growth attributes were observed in the unweeded control plot i.e. (W_5) at all the growth stages of rapeseed crop from 25 DAS till harvest during both the years as well as in pooled data.

From the results above, it can be concluded that the competition between crops and weeds was less from the very early stage of the crop till maturity facilitating higher nutrient and water uptake, accelerated photosynthetic activity, availability of optimum space for better crop growth resulting into higher dry matter accumulation and higher values of growth attributes and partitioning of dry matter towards seed formation Nath *et al*. (2015) [24]. Randhawa *et al*. (2007) [15] also observed that pre and post emergence herbicides do not persist in soil and can have no adverse effect on the succeeding crop.

Among the nutrient management practices, significantly variation growth attributes like plant height, number of branches $plant^{-1}$, dry matter accumulation (g m^{-2}) and crop growth rate (g m^{-2} day^{-1}) were found to be highest in the application of 75% RDF nitrogen as urea + 25% RDF nitrogen as loktakphumdi compost (N_2) with (67.50 cm, 4.39, 285.88 g m^{-2} and 3.55 g m^{-2} day^{-1}) significantly closely followed by the application of 50% RDF nitrogen as urea + 50% RDF nitrogen as loktakphumdi compost i.e. (N_3). Application of 100% RDF nitrogen as loktakphumdi compost i.e. (N_4) in the preceding crop had the lowest residual effect on the growth of rapeseed crop. Application of 75% inorganic and 25% organic fertilizers after soil test value might have increased the availability of nitrogen to the plant at early growth stages and nitrogen being an essential constituent of nucleic acid, protoplasm and protein, play a fundamental role in metabolism, growth, development, reproduction and transmission of heritable characters. These results were in conformity with those of Prasad and Ehsanullah (1988) [13].

Residual effect of integrated weed and nutrient management on yield attributes and yield of rapeseed at harvest

Yield attributes

Different integrated weed and nutrient management practices significant residual effect on the number of siliquae plant^{-1} of succeeding rapeseed crop (Table 5). The pooled data revealed that application of pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS (W_3) gave the highest number of siliquae plant^{-1} (16.17) which was comparable with the plot receiving post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS (W_2) with a value of (14.79) but they were significantly higher than the unweeded control plot (W_5) (9.72). Similarly, maximum number of seeds siliqua^{-1} (24.58) was observed in the application of pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS i.e. (W_3) which was statistically comparable with the treatment of post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS (W_2) with (21.89) number of seeds siliqua^{-1}. Lowest number of seeds siliqua^{-1} were recorded in the unweeded control plot (W_5) with (16.06).

Among the nutrient management practices, the yield attributes *viz*., number of siliquae plant^{-1} and number of seeds siliqua^{-1} (14.54, 22.22) were found to be highest in the application of 75% RDF nitrogen as urea + 25% RDF nitrogen as loktakphumdi compost (N_2) and least residual effect was observed in the application of 100% RDF nitrogen as loktakphumdi compost (N_4) value of (10.66, 17.92). Addition of 25% organic fertilizers in combination of 75% chemical fertilizers gave higher values than other treatment combination but the differences were not significant. A number of investigators have observed increases in these attributes in mustard crop *viz*., Tripathi *et al.* (2011) [23], Chaurasia *et al.* (2009) [2], Ramesh *et al.* (2009) [14] and Kashved *et al*. (2010) [8]. The results of present study are in agreement with the findings of above workers. The rate of availability of nutrients in these treatments where in manures were used in conjunction with fertilizers might be well in tune with the crop requirement to reflect in terms of increased primary and secondary branches, dry matter accumulation and chlorophyll content. On pooled data all nutrient management treatments increased the number of seeds siliqua^{-1} over control which might be due to synthesis of more food material resulting in higher grain production and it was also supported by Mandal and Sinha (2004) [10], Tripathi *et al.* (2010) [22] and Singh and Pal (2011) [21].

Yield

It is evident from Table 6 that the various integrated weed and nutrient management practices given in preceding kharif rice had significantly residual effect on the yield of succeeding rapeseed crop. Higher seed and stover yield was observed in the plot receiving pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS i.e. (W_3) value of (1121 kg ha^{-1} and 3073 kg ha^{-1}) but with no significant difference between them. The lowest seed and stover yield was recorded with the unweeded control plot (W_5) with value of (995 kg ha^{-1} and 1827 kg ha^{-1}). It is therefore evident from the above results that the herbicides applied in preceding rice had no harmful residual effect on the growth and yield of succeeding rapeseed crop. Similar findings were also recorded by Bijarnia *et al*. (2017) [1] and Sharma *et al*. (2014) [18]. The lowest yield were recorded in the unweeded control plot may be due to severe competition by weeds for resources, which made the crop plant incompetent to take up more moisture and nutrients, consequently growth was adversely affected. Similar finding was also recorded by Bijarnia *et al*. (2017) [1].

Among the different integrated nutrient management practices, maximum seed and stover yield were recorded in the plot receiving 75% RDF nitrogen as urea + 25% RDF nitrogen as loktakphumdi compost (N_2) value of (1096 kg ha^{-1} and 2541 kg ha^{-1}) which was significantly followed by (N_3 and N_1) i.e. application of 50% RDF nitrogen as urea + 50% RDF nitrogen as loktakphumdi compost and application of 100% RDF nitrogen as urea. Application of 100% RDF nitrogen as loktakphumdi compost i.e. (N_4) gave the lowest seed and stover yield of (1076, kg ha^{-1} and 2343 kg ha^{-1}), respectively. The favourable effect of conjunctive use of FYM with inorganic fertilizers on seed yield was due to more number of siliqua and greater dry matter accumulation and more yield attributes *viz*., number of siliquae plant^{-1} and number of seeds siliqua^{-1}. The yield advantage of integrated of organic sources with inorganic fertilizers and also biofertilizer form associative symbiosis with plants. The straw yield increased with INM could be partly attributed to its direct influence on dry matter production of each vegetative part and indirectly through increased morphological parameters of growth. Since, biological yield is a function of seed and straw yield representing vegetative and reproduction growth of crop. These results are in agreement with the findings of Singh and Rai (2004) [20], Singh and Pal (2011) [21], Tripathi *et al*. (2010) [22] and Regar *et al*. (2009) [16]. The increased availability of these nutrients in root zone coupled with increased metabolic activity at cellular level might increase nutrient uptake and their accumulation in vegetative plant parts. Increased accumulation of nutrients in vegetative plant parts with improved metabolism led to greater translocation of these nutrients to reproductive organs of the crop and ultimately increased the contents in seed and straw. These results are in line with the finding of Chaurasia *et al*. (2009) [2] and Singh *et al*. (2011) [21].

Oil yield

It is evident from Table 6 that different integrated weed and nutrient management practices had significant residual effect on the oil yield of succeeding rapeseed crop. The pooled data revealed that among the different weed management practices, application of pre-emergence (Pyrazosulfuron ethyl 10% W.P. @ 0.025 kg a.i/ha) at 5 DAS + post-emergence (Bispyribac-sodium 10SC 9.5% w/w @ 0.025 kg a.i/ha) at 20 DAS (W_3) recorded significantly higher oil yield (350.50 kg ha^{-1}) but it was significantly higher than the remaining treated plots (W_2, W_1 and W_4). The unweeded control plot (W_5) gave the lowest oil yield with a value of (256.98 kg ha^{-1}).

Among the nutrient management practices, the oil yield was found to be maximum in the application of 75% RDF nitrogen as urea + 25% RDF nitrogen as loktakphumdi compost i.e. (N_2) value of (330.98 kg ha^{-1}) which was significantly higher than (N_3, N_1 and N_4) of (319.77 kg ha^{-1}, 307.83 kg ha^{-1} and

296.35 kg ha^{-1}), respectively. This might be attributed to the increased availability of nutrients that involved in an increased conversion of primary fatty acids metabolites to the end products of fatty acid as supported by Tripathi *et al.* (2010) [22]. Further higher levels of fertilizers improved more availability of nitrogen which increased the proportion of protein aciuous substance in the seed. Under high nitrogen supply, a large proportion of potosynthates may have diverted to protein formation leaving a potential deficiency of carbohydrates to be degraded to 'acetyl co-enzyme A' precursor of fatty acids resulted in to low oil content. These results are in close conformity with the findings of (Shukla *et al*. 2002, Singh and Pal, 2011) [21]. The essential elements like secondary and micronutrient contained in FYM and biofertilizer probably promoted the synthesis of oils. In addition to supplying micronutrients, FYM also increases fertilizer use efficiency and make the phosphate in the soil more available to plants even in slightly acidic soil. All these reasons reflected positively in improving yield and ultimately oil yield in rapeseed. Similar results was also observed by Singh *et al.* (2012) [19] and Mookherjee *et al.* (2014) [11].

Table 1: Residual effect of integrated weed and nutrient management practices on plant height (cm) of rapeseed

	25 DAS			50 DAS			75 DAS			Harvest		
Treatment	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**
W1	12.62	13.12	12.87	35.06	36.10	35.58	54.74	55.26	55.00	64.22	64.79	64.51
W2	13.23	14.01	13.62	37.36	38.37	37.87	57.51	58.11	57.81	65.77	67.22	66.49
W3	14.12	15.05	14.58	40.22	41.34	40.78	61.18	62.56	61.87	69.57	70.36	69.97
W4	12.15	12.30	12.23	33.16	33.74	33.45	52.05	53.40	52.72	61.87	61.87	61.87
W5	11.76	11.30	11.52	30.11	31.73	30.92	48.28	48.46	48.37	55.75	56.42	56.09
SE.d(±)	0.19	0.16	0.17	0.72	0.71	0.70	0.37	0.43	0.39	0.50	0.43	0.44
C.D(p=0.05)	0.44	0.36	0.39	1.66	1.63	1.61	0.84	0.98	0.90	1.14	0.98	1.02
N1	12.08	12.76	12.41	33.96	35.68	34.82	53.74	54.45	54.10	62.53	62.60	62.56
N2	14.25	14.85	14.55	38.66	39.22	38.94	58.46	59.13	58.79	67.00	68.00	67.50
N3	13.42	13.69	13.55	36.70	37.50	37.10	55.87	56.26	56.06	64.19	65.37	64.78
N4	11.36	11.32	11.35	31.40	32.63	32.01	50.94	52.38	51.66	60.02	60.56	60.29
SE.d(±)	0.06	0.06	0.05	0.20	0.16	0.17	0.14	0.13	0.11	0.16	0.16	0.13
C.D(p=0.05)	0.12	0.12	0.11	0.41	0.33	0.34	0.28	0.26	0.23	0.32	0.33	0.27

Table 2: Residual effect of integrated weed and nutrient management practices on number of branches $plant^{-1}$ of rapeseed

	50 DAS			75 DAS			Harvest		
Treatment	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**
W1	3.41	3.48	3.45	3.61	3.72	3.66	4.03	4.16	4.09
W2	3.49	3.55	3.52	3.67	3.77	3.72	4.13	4.26	4.20
W3	3.54	3.60	3.57	3.74	3.85	3.79	4.36	4.49	4.42
W4	3.24	3.30	3.27	3.43	3.53	3.48	3.75	3.91	3.83
W5	2.98	3.05	3.01	3.18	3.28	3.23	3.58	3.71	3.64
SE.d(±)	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
C.D(p=0.05)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
N1	3.20	3.26	3.23	3.39	3.50	3.44	3.88	4.02	3.95
N2	3.81	3.88	3.84	4.01	4.11	4.06	4.33	4.46	4.39
N3	3.31	3.37	3.34	3.50	3.60	3.55	4.09	4.22	4.16
N4	3.01	3.08	3.04	3.21	3.29	3.25	3.57	3.72	3.64
SE.d(±)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C.D(p=0.05)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Table 3: Residual effect of integrated weed and nutrient management practices on dry matter accumulation (g m^{-2}) of rapeseed

	25 DAS			50 DAS			75 DAS			Harvest		
Treatment	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**
W1	18.30	20.48	19.39	56.88	59.07	57.98	161.13	163.32	162.23	257.60	260.15	258.88
W2	21.31	23.49	22.40	66.03	68.15	67.09	172.28	174.45	173.36	272.57	273.68	273.13
W3	23.57	25.42	24.49	69.51	71.74	70.63	178.43	180.63	179.53	283.49	284.59	284.04
W4	15.53	17.68	16.61	53.16	55.36	54.26	152.40	154.59	153.49	247.53	249.73	248.63
W5	13.61	15.78	14.69	48.79	52.13	50.46	144.56	148.74	146.64	236.09	240.28	238.18
SE.d(±)	1.25	1.26	1.26	0.55	0.52	0.54	0.75	0.75	0.75	0.95	0.95	0.95
C.D(p=0.05)	N.S	N.S	N.S	1.27	1.20	1.23	1.74	1.73	1.73	2.18	2.19	2.18
N1	18.04	20.13	19.08	58.01	60.14	59.08	157.42	160.01	158.71	251.18	253.54	252.36
N2	19.59	21.76	20.67	61.73	64.19	62.96	179.44	182.03	180.73	285.04	286.73	285.88
N3	18.74	20.94	19.84	60.09	62.67	61.38	162.09	164.68	163.39	264.29	266.66	265.47
N4	17.49	19.45	18.47	55.66	58.15	56.91	148.08	150.66	149.37	237.32	239.81	238.57
SE.d(±)	0.22	0.22	0.22	0.18	0.18	0.18	0.30	0.30	0.30	0.37	0.35	0.35
C.D(p=0.05)	N.S	N.S	N.S	0.37	0.36	0.36	0.62	0.62	0.62	0.75	0.71	0.72

Table 4: Residual effect of integrated weed and nutrient management practices on crop growth rate (g m^{-2} day^{-1}) of rapeseed

	25 - 50 DAS			50 - 75 DAS			75 - Harvest		
Treatment	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**
W1	1.29	1.29	1.29	3.48	3.55	3.51	3.22	3.30	3.26
W2	1.49	1.49	1.49	3.54	3.62	3.57	3.34	3.38	3.36
W3	1.53	1.55	1.54	3.63	3.70	3.67	3.50	3.54	3.52
W4	1.26	1.26	1.26	3.31	3.38	3.34	3.17	3.24	3.21
W5	1.17	1.21	1.19	3.19	3.33	3.26	3.05	3.19	3.12
SE.d(±)	0.04	0.04	0.04	0.03	0.02	0.02	0.02	0.03	0.02
C.D(p=0.05)	N.S	N.S	N.S	0.07	0.04	0.05	0.05	N.S	0.06
N1	1.33	1.33	1.33	3.31	3.40	3.35	3.13	3.20	3.16
N2	1.41	1.41	1.41	3.92	4.01	3.96	3.52	3.58	3.55
N3	1.38	1.39	1.38	3.40	3.49	3.44	3.41	3.49	3.45
N4	1.27	1.29	1.28	3.08	3.17	3.12	2.98	3.06	3.01
SE.d(±)	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
C.D(p=0.05)	N.S	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02

Table 5: Residual effect of integrated weed and nutrient management practices on yield attributes of rapeseed

	No. of siliqua $plant^{-1}$			No. of seed $siliqua^{-1}$		
Treatment	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**
W1	12.08	12.49	12.28	19.47	20.79	20.13
W2	14.34	15.24	14.79	20.70	23.08	21.89
W3	15.90	16.44	16.17	23.54	25.62	24.58
W4	10.34	10.89	10.61	18.23	18.77	18.50
W5	9.57	9.88	9.72	15.71	16.40	16.06
SE.d(±)	0.49	0.26	0.34	0.37	0.27	0.26
C.D(p=0.05)	1.14	0.60	0.78	0.84	0.63	0.59
N1	11.67	12.61	12.14	19.01	20.66	19.83
N2	14.73	14.36	14.54	21.60	22.84	22.22
N3	13.49	13.55	13.52	20.24	21.67	20.95
N4	9.89	11.43	10.66	17.27	18.56	17.92
SE.d(±)	0.17	0.07	0.10	0.12	0.11	0.09
C.D(p=0.05)	0.34	0.15	0.21	0.24	0.22	0.18

Table 6: Residual effect of integrated weed and nutrient management practices on yield of rapeseed

	Grain yield kg ha^{-1}			Stover yield kg ha^{-1}			Oil content kg ha^{-1}		
Treatment	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**	**2017**	**2018**	**pool**
W1	1109.26	1102.65	1105.95	2597.27	2584.27	2590.77	326.42	319.60	323.01
W2	1115.48	1110.79	1113.13	2847.97	2812.35	2830.16	334.92	329.01	331.96
W3	1120.90	1122.20	1121.55	3094.17	3053.14	3073.65	353.69	347.32	350.50
W4	1098.28	1093.28	1095.78	2044.33	2032.28	2038.31	309.90	302.50	306.20
W5	998.26	993.50	995.88	1842.73	1811.88	1827.30	260.08	253.89	256.98
SE.d(±)	0.86	0.99	0.89	25.63	23.70	24.31	2.30	2.26	2.28
C.D(p=0.05)	1.98	2.28	2.05	58.96	54.50	55.91	5.30	5.19	5.24
N1	1086.0	1081.5	1083.7	2515.1	2467.0	2491.1	311.33	304.33	307.83
N2	1097.8	1094.9	1096.3	2562.3	2520.4	2541.4	334.40	327.55	330.98
N3	1091.5	1087.6	1089.6	2536.8	2487.9	2512.4	322.81	316.73	319.77
N4	1078.5	1074.0	1076.2	2326.8	2359.7	2343.3	299.46	293.24	296.35
SE.d(±)	0.34	0.40	0.35	10.47	9.17	9.75	0.65	0.69	0.67
C.D(p=0.05)	0.70	0.81	0.72	21.35	18.71	19.90	1.33	1.41	1.36

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