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Weed management in rice-based crops and mustard crop performance

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Abstract:

The present field experiment was conducted at Assam Agricultural University, Jorhat, Assam with Sesbania-winter rice (Oryza sativa L.)-Indian mustard (Brassica juncea L.) cropping sequence during 2017-2019 comprising 20 treatment combinations of tillage and weed management practices. The study revealed that seed, stover and oil yield of Indian mustard were increased in the year round minimum tillage with rice residue retention by 35.97, 23.41 and 38.90%, respectively due to higher crop growth characteristics and yield attributes as compared to conventional tillage. Among weed management practices, integrated weed management (IWM) showed higher weed control efficiency (WCE) and weed control index (WCI) as well as improved seed and oil yield by 39.66 and 39.61%, respectively as compared to weedy check. Combination of minimum tillage along with rice residue retention and IWM enumerated higher oil yield (6.40 q/ha) of Indian mustard grown after direct seeded rice (DSR) under minimum tillage. The findings of the experiment implied that minimum tillage with rice residue retention along with integrated weed management encouraged crop growth and productivity of Indian mustard (IM) as a succeeding crop after direct seeded rice grown under minimum tillage condition.

Keywords:

Indian mustard, integrated weed management, Minimum tillage, Rice residue retention, Seed yield

1. Introduction:

Indian mustard (Brassica juncea L.) is one of the widely grown oilseed crop under different agro-climatic conditions of India. In Assam, rape and mustard occupies an area of 2.88 lakh ha with production and productivity of 1.77 lakh tonnes and 617 kg/ha, respectively (Statistical Handbook Assam 2021). Indian mustard variety with short and medium duration is preferred to cultivate after sali rice in medium land of Assam. However, loses in upland characteristics of such typically puddled transplanted rice (TR) is a crucial issue that negatively impact on germination, growth and productivity in the winter (rabi) crops. In transplanted rice, puddling disturbs the soil health due to dispersion of soil particles, increases soil compaction making more investment and energy in tillage operations to sow the succeeding crop. Farmers who have adopted conservation agriculture require 40% of less time, labour and fuel as compared to conventional agriculture (Govindan and Chinnusamy 2014). Conservation tillage minimizes soil disturbance and thus, overcomes the aforementioned problems and optimizes mustard yield grown after winter rice. Even though, such tillage system is attaining worldwide acceptance for various environmental and economic profits but, adoption of it results changes in extent of weed infestation leading weed management as the foremost bottleneck under conservation tillage practices, if effective weed control measures are not adopted. Weed management requires special attention to harness the full profitability of conservation tillage (Teja et al. 2017). An efficient weed management strategy is crucial for optimum productivity under conservation tillage system adopted for the winter rice-Indian mustard cropping sequence with Sesbania aculeata as the preceding green manuring crop. Generally, in conservation tillage weed can be managed manually or by applying herbicides. However, due to scarcity in labour availability at the time of critical crop weed competition and less availability of herbicides with broad spectrum weed control, integrated weed management is expected option to attain the benefit of conservation tillage. Therefore, the field study was carried out to see the performance of Indian mustard in year round conservation tillage and weed management practices in transplanted and direct seeded rice fallow.

2. Materials and methods:

The present experiment was conducted at the Instructional- Cum-Research (ICR) Farm, Assam Agricultural University, Jorhat, Assam (26°44'N, 94°10'E and 91.0 m amsl) during 2017-19. The soil of the experimental site was sandy loam with pH 5.59, organic carbon 0.62%, available N 290.60 kg/ha, available P2O5 21.70 kg/ha and available K2O 128.90 kg/ha. Total amount of

rainfall of the site was 94.0 and 99.4 mm during rabi, 2017-18 and 2018-19, respectively. The experiment consisted of 20 treatment combinations with 5 tillage practices in the main plots, viz. CT (Sesbania)-CT (transplanted rice)-CT (Indian mustard) (T1); MT (Sesbania)-CT (transplanted rice)-MT (Indian mustard) (T2); MT (Sesbania)-CT (direct seeded rice)-CT (Indian mustard) (T3); MT (Sesbania)-MT (direct seeded rice)-MT+R/rice residue (Indian mustard) (T4); and MT (Sesbania)-MT (direct seeded rice)-MT (Indian mustard) (T5) and 4 weed management practices in the sub plots, viz. recommended herbicides (Sesbania: pendimethalin 0.75 kg/ha pre-emergence; rice: pretilachlor 0.75 kg/ha pre-emergence; Indian mustard: pendimethalin 0.75 kg/ha on dry-matter accumulation/plant were recorded by taking average of 5 randomly selected oven dried plants (at 60±5oC). Crop growth rate was calculated using formula of Watson (1952) and expressed as g/m^2/day. The leaf area index was calculated by dividing the leaf area/plant by land area occupied by the plant. For test weight 1000-seeds were counted, weighed and recorded in gram. The border area was harvested prior to the net area of the plots. After proper sun drying, biological yield in q/ha was recorded before threshing. Seed yield in q/ha was recorded after threshing and winnowing. The stover weight was converted to stover yield in q/ha. Harvest index was calculated by formula of Donald and Hamblin (1976) and expressed in Percent (%). Seed oil content of Indian mustard was analysed using Soxhlet extraction unit. Oil yield of Indian mustard was calculated with the help of seed oil content and seed yield and expressed in q/ha. For all the aforesaid parameters, pooled data of two years were analysed. Mean of two years WCE and WCI of weed management practices in Indian mustard were calculated by following the formula of Mani et al. (1973) and Misra and Tosh (1979), respectively.

Weed density in weedy check - Weed pre-emergence) (W1); IWM: integrated weed management (Sesbania: pendimethalin 0.75 kg/ha pre-emergence + manual weeding; rice: pretilachlor 0.75 kg/ha pre-emergence + manual weeding; Indian mustard: pendimethalin WCE (%) =density of treated plot × 100 Weed density of weedy check Weed dry matter in weedy check - Weed dry matter in treated plot 0.75 kg/ha pre-emergence + manual weeding) (W2); manual weeding (W3) and weedy check (W4), laid out in a split-plot WCI (%) = Weed dry matter in weedy check × 100 design and replicated thrice (Kalita 2020).

Under conventional tillage (CT) treatment in Sesbania- winter rice-Indian mustard cropping sequence, the field was tilled before sowing of each crop following the recommended package and practices of Assam; whereas, in minimum tillage (MT) secondary tillage operations are reduced to 50% and in MT+R (residue) treatment minimum tillage was done before sowing of Indian mustard and winter rice residue (1.5 t/ha) was retained on the soil surface.

Recommended dose of nitrogen, phosphorous and potassium were applied through Urea, Single super phosphate and Muriate of potash, respectively. Indian mustard variety NRCHB-101 was sown at the seed rate of 8 kg/ha during rabi, 2017-18 and 2018-19 at a row spacing of 30 cm. Thinning was done to maintain the intra row spacing of 7-10 cm at 15 days after sowing (DAS). As per treatment, recommended herbicide of Indian mustard pendimethalin 0.75 kg/ha was applied 2 DAS as pre-emergence herbicide sprayed with knapsack sprayer fitted with flat fan nozzle. As per treatment, manual weeding was done at 25 DAS. Likewise in IWM, pendimethalin 0.75 kg/ha as pre-emergence was integrated with 1 manual weeding at 25 DAS in the crop.

Plant population was counted at 30 DAS using quadrate of 1 m × 1 m. For observations on various parameters like plant height, number of primary and secondary branches, number of siliquae/plant, and seeds/siliqua, 5 randomly tagged plants from each plot was selected and average values were recorded periodically. Periodic observations all the data pertaining to the present investigation were statistically analysed in split-plot design and two years data were pooled analysed as described by Sarma (2016).

3. Results and discussion:

Plant population/m^2: Significantly poorer plant population/m2 at 30 DAS was counted under tillage system with transplanted rice, viz. T1 and T2 as compared to rest tillage practices. The reduction in crop stand under the aforementioned treatments might be owing to the less porous and compact soil caused by puddling operations in preceding transplanted rice crop (Table. 1). Again, among weed management treatments, recommended herbicide, i.e. pre-emergence application of pendimethalin 0.75 kg/ha, manual weeding (25 DAS) and IWM, i.e. pre-emergence application of pendimethalin 0.75 kg/ha followed by manual weeding (25 DAS) noted significant increase in no of plants/m2 over weedy check which might be attributed to less crop weed competition for different growth factors during germination and emergence.

Crop growth characteristics: Different tillage practices significantly affected plant height, LAI (leaf area index), dry-matter accumulation at different stages of crop growth, CGR (crop growth rate) and number of primary, secondary, and total branches/plant of the crop during the study (Table. 1 and 2). Significantly taller Indian mustard plants were observed at all the stages of the crop under T3, T4 and T5 as compared to T1 and T2 (Table. 1). Improper root

Table. 1: Effect of tillage practices and weed management on growth characteristics at different stages of Indian mustard

		25 DAS	**50 DAS**	**75 DAS**	**At harvest**	**25 DAS**	**50 DAS**	**75 DAS**	**25 DAS**	**50 DAS**	**75 DAS**	**At harvest**	**0–25 DAS**	**25–50 DAS**	**50–75 DAS**	**75 DAS harvest**
Tillage practices																
T_1	24.78	12.12	122.13	163.97	169.70	0.93	3.49	2.90	1.58	6.98	17.24	20.98	1.75	5.85	11.40	4.15
T_2	24.51	12.53	124.42	165.98	171.45	0.98	3.56	3.06	1.59	7.18	17.86	21.22	1.77	6.01	11.88	3.73
T_3	26.89	17.46	153.73	189.70	193.47	1.16	3.85	3.35	2.64	8.99	22.99	27.25	2.93	6.78	15.56	4.74
T_4	29.52	18.32	147.49	185.04	188.70	1.40	4.37	3.84	3.56	12.24	27.14	33.12	3.95	9.38	16.56	6.64
T_5	28.49	18.30	148.06	186.27	189.13	1.29	4.21	3.64	3.39	11.77	25.74	31.37	3.76	9.00	15.52	6.22
SEm±	0.58	0.56	3.90	5.17	5.08	0.05	0.11	0.10	0.18	0.42	0.63	0.74	0.19	0.51	0.84	0.35
CD (P=0.05)	1.88	1.805	12.7	16.85	16.56	0.14	0.35	0.32	0.56	1.37	2.04	2.39	0.62	1.65	2.72	1.16
Weed management																
W1	29.25	14.85	141.72	177.58	182.15	1.25	3.70	3.13	3.15	8.94	21.15	25.66	3.63	6.43	13.57	5.02

W2	29.75	14.81	130.03	171.07	176.07	1.38	4.49	4.02	3.54	12.34	26.66	31.40	3.93	9.78	15.92	5.24
W3	27.47	16.22	130.80	172.89	176.84	1.06	4.28	3.81	1.88	11.29	25.68	30.29	2.09	9.46	15.99	5.13
W4	20.88	17.11	151.12	191.23	194.90	0.91	3.11	2.60	1.63	5.17	15.30	19.80	1.81	3.93	11.25	4.85
SEm±	0.60	0.45	3.02	3.56	3.43	0.05	0.10	0.08	0.10	0.45	0.57	0.57	0.11	0.51	0.78	0.19
CD (P=0.05)	1.74	1.30	8.72	10.29	9.89	0.15	0.28	0.22	0.29	1.30	1.64	1.65	0.32	1.49	2.25	NS
Interaction (T × W)																
SEm±	1.34	1.16	6.75	7.97	7.66	0.12	0.22	0.18	0.22	1.01	1.27	1.28	0.25	1.15	1.74	0.39
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3.68	NS	NS	NS	NS

Treatment Population/m2 Plant height (cm) LAI Dry matter accumulation (g/plant) Crop growth rate (g/m^2/day)

TR, Transplanted rice; DSR, Direct seeded rice; IM, Indian mustard; DAS, Days after sowing and NS, Non-significant.

Treatment details are given under Materials and Methods.

Table. 2: Effect of tillage practices and weed management on branches/plant, yield attributes and yield of Indian mustard (pooled data)

Primary	**Secondary**	**Total**	**plant**	**siliqua**	**weight (g)**	**yield (q/ha)**	**yield (q/ha)**	**Cal yield (q/ha)**	**Index (%)**	**Content (%)**	**yield (q/ha)**

Tillage practice												
T_1	5.165	7.91	13.07	151.09	10.36	4.17	10.51	31.44	41.96	24.91	4.01	4.01
T_2	5.345	7.95	13.29	153.63	10.47	4.13	10.55	31.59	42.14	24.89	4.03	4.03
T_3	6.065	10.19	16.25	203.50	11.41	4.25	12.34	35.06	47.56	25.96	4.75	4.75
T_4	6.635	13.06	19.70	217.00	13.28	4.38	14.29	38.80	53.10	26.87	5.57	5.57
T_5	6.475	12.74	19.22	212.84	12.73	4.29	13.56	37.55	51.10	26.33	5.26	5.26
SEm±	0.21	0.44	0.53	6.54	0.42	0.07	0.65	1.30	1.93	-	0.16	0.16
CD at 5%	0.68	1.43	1.72	21.31	1.36	NS	2.54	5.11	7.56	-	NS	0.53
Weed management												
W	5.88	9.05	16.33	189.54	10.84	4.23	10.64	32.08	42.72	24.89	4.09	4.09
1 W	6.945	10.33	19.56	233.04	13.20	4.32	14.86	39.86	54.63	26.98	5.71	5.71
2 W	6.595	11.00	18.74	228.70	13.13	4.30	14.62	39.26	53.88	27.14	5.64	5.64
3 W	4.33	9.88	10.59	99.17	9.42	4.13	8.96	28.39	37.46	24.16	3.48	3.48
4 SEm±	0.29	6.71	0.51	4.65	0.38	0.06	0.32	0.42	0.62	-	0.1	0.13

										3	
CD (P=0.05)	0.84	0.99	1.46	13.42	1.08	NS	1.43	1.87	2.81	- N S	0.37
Interaction (T × W)											
SEm±	0.65	1.26	1.13	10.39	0.84	0.14	0.75	2.79	3.35	- 0.28	0.28
CD (P=0.05)	NS	NS	NS	30.01	NS	NS	NS	8.01	9.74	- N S	0.81

3.1. Treatment details are given under materials and methods:

Development in compacted sub surface soil resultant of preceding transplanted rice crop under puddled condition might be the reason of shorter stature of plants under T1 and T2. Treatment T4 recorded the highest LAI, dry matter accumulation at all the stages, CGR between 0-25, 25-50, 50-75 DAS and 75 DAS-harvest, and primary, secondary and total branches/plant of Indian mustard over all other tillage treatments and was statistically superior over T1 and T2, which might be pertained to taller plant stature, well grown crop canopy with well-developed photosynthetic surface, more uptake of nutrients by the well-developed roots etc. Residue retention could have enriched soil properties and optimised crop micro-climate maximizing dry-matter accumulation of Indian mustard under T4. A higher rate of photosynthesis and assimilation resulted into higher CGR in these treatments.

Different weed management practices significantly affected plant height, LAI, dry-matter accumulation and CGR, and number of primary, secondary and total branches/plant of the crop as compared to weedy check (Table. 1 and 2). During the investigation, recommended herbicide, pendimethalin 0.75 kg/ha pre-emergence, IWM (W1), pendimethalin 0.75 kg/ha pre-emergence + manual weeding 25 DAS (W2) and manual weeding 25 DAS (W3) significantly lowered plant height of Indian mustard at 50, 75 DAS and harvest compared to weedy check (W4)

(Table. 1). Weedy check recorded the highest plant height with very weak growth which might be pertained to phototropism. Application of IWM and recommended herbicide were at par in

respect of LAI of Indian mustard at 25 DAS (Table. 1). However, IWM and manual weeding were statistically superior for LAI at 50 and 75 DAS to all other treatments. The increase in LAI in the mentioned treatments might be due to almost a weed free environment during critical growth period of the crop compared to weedy check which created non-competitive environment for expansion of leaves under reduced weed problem. Data explicated that IWM and manual weeding recorded significantly greater amount of dry-matter accumulation at 50, 75 DAS and harvest, CGR during 25-50, 50-75 and 75 DAS-harvest, and numbers of primary, secondary and total branches/plant compared to weedy check (Table. 1 and 2). The higher dry-matter accumulation, CGR at different stages, and numbers of branches/plant in IWM and manual weeding might be attributed to higher WCE and WCI [Fig 1(A) and 1(B)], almost weed free environment which contributed to greater crop canopy exposure to perceive solar radiations due to reduced weed infestation providing congenial crop growth environment that enhanced rate of photosynthesis and indirectly improved nutrient uptake by the crop.The increment in number of branches under various weed management treatments indicated an increase in gibberellin [Indian Journal of Agricultural Sciences 93 (3)]

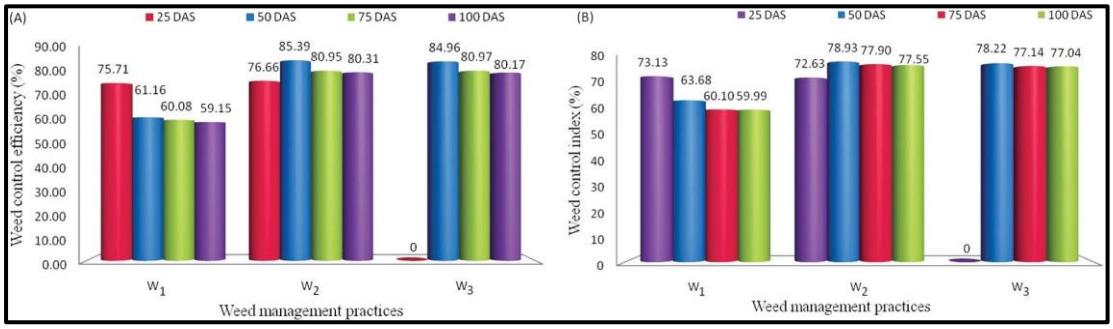

Figure. 1: Two years' mean of WCE (A) and WCI (B) of weed management practices at different stages of Indian mustard

3.2. Details of weed management practices are given under Materials and Methods:

Or more growth of auxiliary buds (Kurchania et al. 1989). Yield attributes: Yield attributing characteristics of Indian mustard like siliquae/plant and number of seeds/siliqua were significantly affected by different tillage practices and weed management treatments at harvest (Table. 2). Data revealed that different tillage and weed management practices did not bring about any significant change in test weight. Maximum number of siliquae/plant and number of seeds/siliqua was counted under T4 treatment. Year round minimum tillage with rice residue retention in Indian mustard enhanced number of siliquae/plant and number of seeds/siliqua. The improvement in these yield attributes of Indian mustard under the aforesaid treatment was

significantly superior over year round conventional tillage system which could be clearly ascribed to appropriate translocation of photosynthates from source to sink.

Table. 3 Interaction effect of tillage practices and weed management on different parameters of Indian mustard

Treatment combination	Dry matter at harvest (g/plant)	ber of siliquae/ plant	tover yield (q/ha)	ological yield (q/ha)	Oil yield (q/ha)
T_1W_1	19.32	162.83	30.69	39.98	3.65
T_1W_2	25.24	172.17	33.74	46.00	4.55
T_1W_3	23.17	173.67	33.74	45.77	4.67
T_1W_4	16.20	95.67	27.61	36.08	3.47
T_2W_1	19.69	173.17	30.56	40.31	4.01
T_2W_2	23.93	169.83	34.65	46.80	4.71
T_2W_3	24.29	172.84	34.10	46.45	4.87
T_2W_4	16.97	98.67	27.05	35.02	3.42
T_3W_1	24.97	199.50	32.47	43.47	4.05
T_3W_2	32.38	268.00	40.14	55.03	5.82
T_3W_3	31.10	259.00	39.37	54.37	6.07
T_3W_4	20.56	87.50	28.50	37.38	3.35
T_4W_1	33.22	210.84	33.65	45.27	4.27
T_4W_2	38.56	277.84	45.92	63.70	6.53
T_4W_3	37.77	268.17	45.31	62.30	6.40
T_4W_4	22.92	111.17	30.33	41.11	3.71
T_5W_1	31.11	201.33	33.04	44.60	3.92
T_5W_2	36.90	277.34	44.87	61.60	6.12
T_5W_3	35.13	269.84	43.79	60.51	6.17
T_5W_4	22.33	102.84	28.48	37.70	3.55

SEm±	1.28	10.39	2.79	3.35	0.28
CD at 5%	3.68	30.01	8.01	9.74	0.81

3.3. Treatment details are given under materials and methods:

As compared to weedy check, significantly improved count of siliquae/plant and seeds/siliqua under IWM might be pertained to reduced crop weed competition for growth factors due to higher WCE (76.66, 85.39, 80.95 and 80.31%, respectively) and WCI (72.63, 78.93, 77.90 and 77.55%, respectively) of the treatment at 25, 50, 75 and 100 DAS [Fig. 1(A) and 1(B)]. It can be stated that least crop weed competition especially during the critical crop growth period gave rise to an important regulatory function on complicated process of yield realization due to improved availability of growth factors, viz. space, water, light and nutrients. Moreover, intercultural operation during IWM and manual weeding soil surface aeration is improved which resulted more nutrient uptake by plant and thus more metabolic activity which considerably influenced 'source' development by virtue of greater photosynthesis and metabolic activity which in turn improved growth of crop and accordingly yield attributing characteristics of the crop (Kalita et al. 2017). Yield and oil yield: Different tillage and weed management practices significantly influenced seed, stover and biological yield of Indian mustard (Table. 2). The highest seed, stover and biological yield of the oilseed crop was recorded under T4 treatment and the respective increase was 35.97, 23.41 and 26.55% in pooled values, respectively over the year round conventional tillage system. This improvement in seed yield might be attributed to upgraded soil physico-chemical and biological properties as well as crop micro-climate under minimum soil disturbance and residue retention which might have led to better overall growth with more photosynthetic area contributing to better yield attributes and yield. Similar finding were reported by Teja and Duary (2018). Comparatively higher harvest index values were noted under T4 (Table. 2). The same treatment increased oil yield by 38.90% as compared to T1 treatment. Among weed management treatments, seed, stover, biological and oil yield of Indian mustard was significantly enhanced by IWM and manual weeding over weedy check (Table. 2). The lesser crop weed competition in IWM and manual weeding could have resulted significantly higher growth and yield attributing characteristics which eventually improved seed, stover and oil yield of the crop.

4. Conclusion:

Treatment combination of T4 and IWM recorded the highest dry matter accumulation (38.56 g/plant), siliquae/ plant (277.84), stover yield (45.92 q/ha) and biological yield (63.70 q/ha) and oil yield (6.53 q/ha) (pooled basis) among all the combinations which might be owing to congenial crop environment under appropriate soil condition and comparatively weed free environment under the treatment combination (Table. 3).

Based on results of two years investigation, treatment combination MT(S)-MT (DSR)-MT+R (IM) (T4) and IWM may be considered as the best for higher productivity as well as oil yield of Indian mustard.

4. References:

(1) Donald C M and Hamblin. 1976. The biological yield and harvest of cereals as agronomic and plant breeding criteria. Advances in Agronomy 28: 361-04.

(2) Govindan R and Chinnusamy C. 2014. Tillage, crop establishment and weed management in rice under conservation agriculture system. Indian Journal of Weed Science 46: 117-22.

(3) Kalita S, Mundra S L, Solanki N S and Sharma N K. 2017. Weed management and nitrogen application for improved yield of mustard. Indian Journal of Weed Science 49(1): 85-87.

(4) Kalita S. 2020. 'Resource conservation practices in winter rice (Oryza sativa L.)-mustard [Brassica juncea (L.) Czern and Coss] cropping sequence'. PhD Thesis, Assam Agricultural University, Jorhat, Assam.

(5) Kurchania S P, Tiwari J P, Trivedi K K and Dubey M P. 1989.

(6) Herbicide weed control in soybean. Pesticide 23: 42-46.

(7) Mani V S, Pandita M L, Gautam KC and Das B. 1973. Weed killing chemical in potato cultivation. Indian Farming 23: 7-23.

(8) Misra A and Tosh GC. 1979. Chemical weed control studies on dwarf wheat. Journal of Research 10: 1-6.

(9) Sarma A. 2016. Agricultural Statistics for Field and laboratory Analysis, 1st edn, pp. 153-79. Kalyani Publishers, New Delhi. Statistical Handbook Assam. 2021. Government of Assam, Directorate of Economics and Statistics Assam, Beltola, Guwahati.

(10) Teja K C, Duary B and Dash S. 2017. Impact of year round conservation tillage and weed management on weed growth and productivity of rice in direct seeded rice-yellow sarson-greengram cropping system. (In) Proceeding of Biennial Conference of the Indian

Society of Weed Science on Doubling Farmers' income by 2022: The Role of Weed Science, MPUAT, Udaipur, Rajasthan, March 1-3, pp. 219.

(11) Teja K C and Duary B. 2018. Weed management and rapeseed mustard productivity in conservation agriculture based rice- yellow mustard-greengram cropping system in lateritic belt of West Bengal. Indian Journal of Weed Science 50(4): 340-44. Watson D J. 1952. The physiological basis of varieties in yield. Advanced Agronomy 4: 101-45.