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Effect of integrated nutrient management and weed control measures on growth and yield attributes of mustard (*Brassica juncea* L.)

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Abstract
An experiment were conducted during the winter season of 2014-15 and 2015-16 at Bikaner, to evaluate the integrated nutrient management and weed control measures on weed, growth, yield attributes and yield of mustard (*Brassica juncea* L.). The highest dry matter of different weeds, growth parameters viz. plant height, dry matter accumulation and leaf chlorophyll, yield parameters like number of silique per plant and seeds per siliqua which laid to the highest seed and straw yield under the treatment 5 t FYM + 100 % RDF and 5 t FYM + 75 % RDF + biofertilizer. Among the weed management sources application of 1.0 kg ha^{-1} pendimethalin reduced the dry matter of different weeds and enhance the growth, yield attributes and also produced the maximum seed and straw yield. A strongly significant and negatively correlation was observed between total dry matter of weeds and yield but strongly and positively correlation was yield attributes and yield of mustard.

Keywords: INM, biofertilizer, FYM, weed control, mustard

1. Introduction

Globally, India accounts for 17.27 percent and 9.07 percent of the total acreage and production of rapeseed-mustard (USDA 2016) respectively. India is the third largest rapeseed-mustard producer in the world after Canada and China. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop. In India, it is grown on 5.8 million hectare, with an annual production of 6.3 million ton ne during 2014-15. Rajasthan is one of the major mustard producing states in the country, with an annual production of 2.9 million tonne and area 2.47 million hectare during 2014-15.

Soils of northwestern Rajasthan developed under harsh arid tropical climate and are inherently poor in organic matter, fertility and water holding capacity. So integrated nutrient management involving efficient use of organic manures, bio-fertilizers and inorganic fertilizers can substantially enhance crop production, while minimizing environmental pollution. The use of organic manure (FYM) or other farm waste is the tool to improve the physical, chemical and biological properties of the soil. FYM being the source of all essential elements, improves soil organic matter. FYM also plays important role inhabitating beneficial bacterias thus makes nutrients available to crops. In western Rajasthan, mustard area is expanding due to the availability of irrigation water from the Indira Gandhi Canal System. Working out balance fertilizer schedule through integrated approach of organic and inorganic can be an effective measure in boosting average yield of mustard in this region. In integrated nutrient management approach biofertilizer can play an important role. In intensive crop cultivation require the higher use of chemical fertilizer which are costly input.

Mustard is grown on poor soils with poor management practices. Weed infestation is one of the major causes of low productivity. Yield losses due to crop weed competition in rapeseed and mustard have been estimated to the tune of 10-58 percent or even beyond 23-70 percent depending upon the type, intensity and duration of competition. Competition by weeds at initial stages is a major limiting factor to its productivity. Manual weeding at 3-4 weeks after sowing is the most common practice to control weeds in Indian mustard. But increasing wages and scarcity of labour compel to search for other alternatives and the important alternative to manual weeding seems to be herbicidal weed control.

Materials and methods

An field experiment wer conducted during the winter season of 2014-15 and 2015-16 at COA, SKRAU Bikaner (28.01^{0}N, 73.22^{0}E, 234.7 m above mean sea level).

The climate of this zone is typically arid characterized by aridity of the atmosphere and slight salinity in the rhizosphere with extremes of temperature both in summers and winters. The average annual rainfall of the tract is about 260 mm which is mostly received during the rainy season from July to September. Soils are loamy sand with 82.9 % sand, 10.4 % silt and 6.5 % clay. The soil of 0-30 cm had 0.11 % organic carbon, 116.3 kg ha^{-1} N, 18.2 kg ha^{-1} P and 242.3 kg ha^{-1} K. The mustard RGN 48 was sown at 30 cm row spacing. The experiment consisting of 6 nutrient management viz. control, 100 % of RDF, 5 t FYM + 75 % of RDF, 5 t FYM + 100 % of RDF, 5 t FYM + 50 % of RDF+ biofertilizer (*Azospirillum* and PSB) and 5 t FYM + 75 % of RDF+ biofertilizer (*Azospirillum* and PSB) and 5 weed control measures viz. Weedy Check, weed free, pendimethalin (1 kg ha^{-1}) PE, Quizalofop-ethyl (60 g ha^{-1}) POE at 25 DAS and Pendimethalin (0.75 kg ha^{-1}) PE+ Quizalofop-ethyl (45 g ha^{-1}) POE at 25 DAS was laid out the split plot design. Half dose of nitrogen and full dose of phosphorous and potassium was applied basal at the time of sowing. Remaining nitrogen fertilizer was applied in 2 equal splits – at 25 and 45 DAS in mustard. The plot size is 4.0 m x 3.0 m for each treatment. The data on density and dry matter of individual weeds at harvest randomly placing two quadrates (0.5 x 0.5 m) per plot and converted in m^2. The dry weight of weeds was recorded by keeping the weeds in oven at 70^o C till constant weight was achieved.

For growth attributes like plant height, branches per plat and dry matter accumulation, five plants randomly selected and the mean of these computed but for leaf chlorophyll at 50 DAS leaf take different place in the each plot after mix of that leaves and sample taken from these mixture.

Number of siliquae of five randomly selected plants was counted and their mean was computed to express as number of siliquae plant^{-1}. Ten siliquae of mustard were randomly selected at harvesting. The seeds siliquae^{-1} counted of ten siliquae from each plot and its computed and express as number seeds siliquae^{-1}. A small seed sample was taken from the produce of each of the net plot harvested and 1000-seeds were counted and their weight was recorded as test weight (g). The seed yield of each net plot (inclusive of tagged plants) was recorded in kg plot^{-1} after cleaning the threshed produce and was converted as kg ha^{-1}. Stover yield was obtained by subtracting the seed yield (kg ha^{-1}) from biological yield (kg ha^{-1}).

Results and Discussion

Effects on weeds

The experiment field was infested with *Chenopodium album, Chenopodium murale, Rumex dentatus, Asphodelus tenuifolius and Melilotus indica* The effect of integrated nutrient management practices on different weeds were significant (Table 1). The significantly higher and maximum dry matter of total weeds under the treatment of 5 t FYM + 100 % RDF which was at par with all INM treatments over control and 100 % RDF. The application of organic manures mainly FYM to the crops might have resulted in higher weed frequency as the organic manures might have brought weed seeds with them and/or made soil conditions favourable for weed emergence. These findings are in conformity with those reported Aggarwal and Ram (2011) [1] and Kumar *et al*. (2011) [2]

Pendimethalin 1 kg ha^{-1} and pendimethalin 750 g + Quizalofop-ethyl 45 g ha^{-1} significantly reduced the dry matter of *Chenopodium species, Rumex dentatus, Melilotus indica* and total weeds over weedy check and Quizalofop-ethyl 60 g ha^{-1}. Pendimethalin 1 kg ha^{-1} superior in control of weeds over all weed management treatments, however pendimethalin 1.0 kg ha^{-1} treatment was found the most superior treatment which controlled to the extent 63.4 percent of total weeds at harvest in comparison to weedy check. The Quizalofop-ethyl 60 g ha^{-1} failed to control the weeds, Quizalofop-ethyl control only monocot grassy weeds hence treatments involved Quizalofop-ethyl alone or in combination with pendimethalin had poor weed control under total weeds (Table 1) In the present study, the dicots weeds were dominating than monocots. Pendimethalin is known to be adsorbed by germinating weeds and disrupts the cell division, especially mitotic process mostly in meristematic tissue of weeds which are responsible for lateral and secondary root formation. Pooled results indicated that pendimethalin 1 kg ha^{-1} was recorded lowest pooled weed index of 2.4 percent.

Growth attributes

The plant height increased by all the nutrient management treatments at 45 DAS and harvest over 5 t FYM + 50 % RDF + biofertilizer, 5 t FYM + 75 % RDF and control (Table 1). Dry matter accumulation was significantly influenced due to integrated nutrient management treatments. Maximum no. of branches and dry matter was recorded under 5 t FYM + 100 % RDF at different stages being at par with that of 5 t FYM + 75 % of RDF + biofertilizer and 100 % of RDF. Chlorophyll content also maximum under all nutrient management treatments over control, however the maximum chlorophyll content recorded under 5 t FYM + 100 % RDF and 5 t FYM + 75 % RDF + biofertilizer. It is established fact that organic manure improve physical, chemical and biological properties of soil and supplies almost all the essential plant nutrients for long term as entire crop period with slow pace while the inorganic fertilizer ensures readily available nutrients for a short period

Weed management significantly increased the growth parameters of mustard Pendimethalin 1 kg ha^{-1} significantly increased the plant height, no. of branches per plant, dry matter accumulation and chlorophyll content over weedy check and Quizalofop-ethyl 60 g ha^{-1}, which was at par with pendimethalin 750 g + Quizalofop-ethyl 45 g ha^{-1}. Quizalofop-ethyl 60 g ha^{-1} failed to improve the growth parameters because it controlled the grassy weeds but the experiment field is infested by broad leaves weeds. The weed free environment provided by these treatments minimized the crop weed competition to the extent of their higher efficacy in weed control that led to the better growth of the crop.

Yield attributes and yield

The yield components, viz., siliquae plant^{-1} and seeds siliqua^{-1} were significantly influenced due to integrated nutrient management treatments over control (Table 2). Crop receiving 5 t FYM + 100 % RDF enhance maximum number of siliquae plant^{-1}, though remained at par with that of 5 t FYM + 75 % RDF + biofertilizer. however the 1000 seed weight of mustard did not significantly influenced by different nutrient management treatments. 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 & secondary branches, dry matter accumulation and chlorophyll content. On pooled data all nutrient management treatments increased the number of seeds siliquae^{-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), Tripathi *et al.* (2010) Singh and Pal (2011). The 1000 seed weight of mustard did not significantly influenced by different nutrient management treatments and this may be due to absorption and translocation of nutrients sufficient for grain formation in all the treatments

Mustard seed, straw and biological yields were significantly higher with the application of different nutrient management sources than control (Table 2) The maximum and significantly higher seed, straw and biological yield was recorded with application of 5 t FYM + 100 % RDF but it was statically at par with 5 t FYM + 75 % of RDF + biofertilizer over rest of the treatments. 5 t FYM + 100 % RDF increases the seed yield by 14.3, 11.4, 7.7 and 58.2 percent16.9, 14.1, 9.5 and 61.9 percent and 16.1, 13.2, 8.9 and 60.7 percent seed, straw and biological over 5 t FYM + 50 % RDF + biofertilizer, 5 t FYM + 75 % RDF, 100 % RDF and control 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 siliqua plant^{-1} and seeds siliqua^{-1}. The yield advantage of integration 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 (plant height and number of branches). 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), Singh and Pal (2011), Tripathi *et al.* (2010) and Regar *et al.* (2009).

Maximum siliquae plant^{-1} seed yield and straw yield was recorded under pendimethalin 1 kg ha^{-1} which was at par with pendimethalin 750 g ha^{-1} + Quizalofop-ethyl 45 g ha^{-1} in comparison to Quizalofop-ethyl 60 gha^{-1} POE and weedy check treatment. However, different weed control treatments did not exhibit their significant impact on seeds per siliqua, test weight and harvest index. The lowest yield attributes and yield was recorded under weedy check and quizalofop-ethyl 60 g ha^{-1}. The lowest value of yield attributes and yield 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. Poor growth of nutrients in weedy check might have produced less photosynthates and partitioned less assimilates to numerous metabolic sink and ultimately poor development of yield components. The poor yield attributes and yield under quizalofop-ethyl 60 g ha^{-1} was due to the poor control of broad leaved weeds like *Chenopodium album, Chenopodium murale, Rumex dentatus, Asphodelus tenuifolius and Melilotus indica.* The higher seed yield obtained with either of these treatments could be better explained by their effectiveness in weed control in comparison to weedy check and quizalofop-ethyl 60 g ha^{-1}. These superior treatments kept the crop almost weed free of weeds upto 30-35 DAS which in turn resulted to significant reduction in competition for nutrients and other growth resources by weeds as a consequence of which reduction in weed dry matter and less competition. Reduced crop-weed competition under these treatments thus saved a substantial amount of nutrients for crop that led to profuse growth enabling the crop to utilize more soil moisture and nutrients from deeper soil layers.

The significantly and negatively correlation was found with total dry weight of weeds and the significantly and positively correlation was occurred in yield attributes viz. no. of silique plant^{-1}, no. of seeds siliqua^{-1}, test weight and yield of mustard. The increased availability of these nutrients in root zone coupled with increased metabolic activity at cellular level might increased 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) and Singh *et al.* (2011).

Table 1: Effect of integrated nutrient management and weed control measures on dry matter of different weeds and growth parameters of mustard (pooled data of 2 years)

Treatments	*Chenopodium species*	*Rumex dentatus*	*Asphodelus tenuifolius*	*Melilotus indica*		Total weeds		WCE %	Plant height		Branches (No plant^{-1})		Dry Matter accumulation
	Dry matter	Dry matter	Dry matter	Dry matter		Dry matter	At harvest	45 DAS	Harvest		Primary Secondry	30 DAS	60 DAS Harvest
Integrated nutrient management													
Control	8.03	14.77	2.45	3.39	31.58	-	37.65	146.6	4.57	10.54	1.28	5.83	20.70
100 % of RDF	9.07	16.89	2.85	3.95	35.97	-	51.87	168.7	5.64	12.25	1.44	7.12	27.83
5 t FYM +75 % of RDF	10.21	18.38	3.09	4.45	39.80	-	48.81	165.0	5.40	12.00	1.42	7.04	27.71
5 t FYM +100 % of RDF	10.55	19.30	3.25	4.65	41.49	-	55.40	183.5	5.97	13.42	1.47	7.31	29.80
5 t FYM+50 % of RDF+ Biofertilizer	9.91	17.96	3.06	4.35	38.92	-	47.98	162.1	5.31	11.76	1.35	6.83	27.34
5 t FYM+75 % of RDF+ Biofertilizer	10.38	18.92	3.19	4.56	40.92	-	54.43	177.8	5.92	13.08	1.45	7.26	29.18
SEm±	0.31	0.51	0.05	0.13	0.88	-	1.27	3.1	0.11	0.25	0.03	0.10	0.42
CD (P=0.05)	0.93	1.50	0.16	0.38	2.61	-	3.75	9.2	0.34	0.75	0.08	0.30	1.24
Weed control measures													
Weedy Check	17.76	32.73	3.73	7.88	70.28	0	45.89	155.4	5.14	11.29	1.33	6.39	25.37
Weed free	0.00	0.00	0.00	0.00	0.00	100	52.62	178.6	5.81	13.14	1.48	7.23	28.99
Pendimethalin 1 kg ha^{-1} P.E.	4.90	9.64	3.73	2.19	23.39	63.94	51.54	176.5	5.63	12.70	1.43	7.10	27.84
Quizalofop-ethyl. 60 gha^{-1} at 25 DAS	17.65	32.08	3.73	7.72	64.90	6.91	47.45	159.4	5.21	11.44	1.36	6.74	25.83
Pendi. (0.75 kg ha^{-1}) PE+ Q.E. (45 gha^{-1}) at 25 DAS	8.14	14.07	3.72	3.33	32.06	52.06	49.29	166.6	5.55	12.32	1.40	7.03	27.43
SEm±	0.31	0.53	0.08	0.12	0.78	-	0.96	2.8	0.10	0.23	0.03	0.09	0.38
CD (P=0.05)	0.87	1.50	0.22	0.34	2.18	-	2.69	8.0	0.27	0.63	0.08	0.27	1.06

Table 2: Effect of integrated nutrient management and weed control measures on Chorophyll content, yield attributes and yields of mustard (pooled data of 2 years)

Treatments	Chorophyll content			No of Silique plant^{-1}	No of seeds Siliquae^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index
	a	b	Total							
Integrated nutrient management										
Control	1.03	0.582	1.61	112.4	11.47	4.03	1117	2388	3505	31.95
100 % of RDF	1.09	0.633	1.72	154.3	12.48	4.13	1641	3531	5172	31.75
5 t FYM +75 % of RDF	1.07	0.622	1.70	149.3	12.33	4.12	1586	3389	4976	31.94
5 t FYM +100 % of RDF	1.16	0.659	1.82	170.8	12.55	4.18	1767	3867	5633	31.39
5 t FYM+50 % of RDF+ Biofertilizer	1.06	0.616	1.68	142.5	12.13	4.10	1545	3308	4853	31.86
5 t FYM+75 % of RDF+ Biofertilizer	1.12	0.652	1.77	161.6	12.51	4.16	1735	3752	5487	31.67
SEm±	0.01	0.006	0.02	3.2	0.24	0.05	25	69	88	0.34
CD (P=0.05)	0.04	0.019	0.05	9.3	0.72	NS	75	203	258	NS
Weed control measures										
Weedy Check	1.04	0.599	1.64	122.0	11.84	4.05	1350	2854	4204	32.17
Weed free	1.14	0.657	1.80	171.0	12.51	4.16	1751	3803	5554	31.55
Pendimethalin 1 kg ha^{-1} P.E.	1.11	0.644	1.76	165.5	12.49	4.15	1710	3687	5397	31.75
Quizalofop-ethyl. 60 gha^{-1} at 25 DAS	1.06	0.602	1.66	127.6	12.11	4.08	1357	2926	4283	31.76
Pendi. (0.75 kg ha^{-1}) PE+ Q.E. (45 gha^{-1}) at 25 DAS	1.09	0.635	1.73	156.2	12.27	4.14	1658	3593	5251	31.56
SEm±	0.01	0.006	0.02	3.7	0.23	0.04	24	54	72	0.27
CD (P=0.05)	0.16	0.017	0.04	10.3	NS	NS	66	152	203	NS

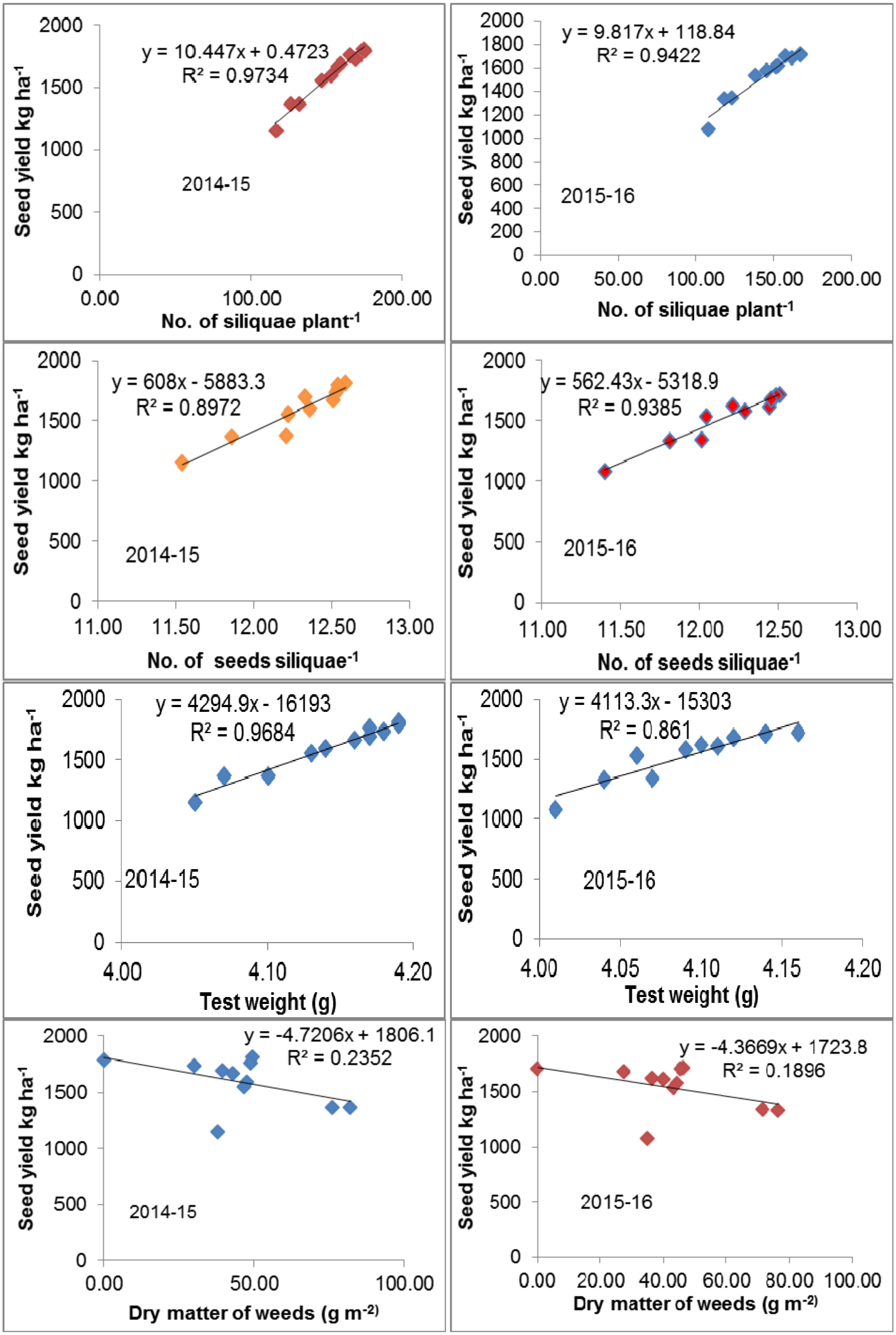

Fig 4.1: Correlation of mustard seed yield with yield attributes and dry matter of weeds

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