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Sanjeev Kumar Kashyap
Department of Agronomy, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Rajesh Kumar Singh
Department of Agronomy, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

AV Dahiphale
Department of Agronomy, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Correspondence
Sanjeev Kumar Kashyap
Department of Agronomy, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Compitative behavior of mustard [*Brassica juncea* (L.) czernj. and cosson] varieties against weeds

Sanjeev Kumar Kashyap, Rajesh Kumar Singh and AV Dahiphale

Abstract
A experiment was conducted during winter (*rabi*) season of 2011-12 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (India), situated under North East Plain Zone of the country. The geographical situation of the farm lies in the North-Gangetic Alluvial plain. The experiment was laid out in Factorial Randomized Block Design comprised of 14 treatment combinations along with three replications. The treatment comprising of seven varieties *i.e.* Kranti, Rohini, Basanti, Maya, NRCHB-101, Ashirwad and Varuna and two weed treatments including weed free and weedy check The lowest density of monocot weed, total weeds and dry matter of weeds was recorded in Rohini, in case of dicot weed density lowest was recorded in Rohini which was at par with NRCHB-101. Whereas in case of growth attributes Rohini attended maximum Plan height over the rest of varieties. In case of number of leaf, chlorophyll content, primary and secondary branches it was observed that Rohini shows its superiority over rest of the varieties except NRCBH-101. It was noticed that significant higher grain yield was observed in Rohini (2102 kgha^{-1}) which was at par with NRCHB-101 and Basanti. In case of straw yield, harvest Index and oil content Rohini, NRCHB-101 and Varuna were shows their dominancy respectively during the period of investigation.

Keywords: Mustard, weed, varieties

Introduction
Oilseeds constitute the second largest agricultural commodity in India after cereals accounting for nearly 6 per cent of gross national product and 10 per cent of the value of all agricultural products. Despite the fact that India is one of the leading oilseed producing countries in the world, it is not able to meet the edible oil requirement for its vast population. India is the largest rapeseed-mustard growing country in the world, occupying the first position in area and second position in production after China.

Rapeseed & Mustard is widely grown in majority of Continents with largest area of 8 million ha in Canada followed by China (7million ha) and India (6 million ha) Majority of the countries grow rapeseed, whereas, India has largest area under mustard. The productivity of India is the lowest among the major rapeseed mustard growing countries. As against the World average of 2144 kg/ha, highest productivity of 3640 kg/ha of Europeon Union, the Indian average yield was only 1 161 kg/ha during 2013 -16 (Annonymus, 2017) [1].

Competition among crop and weeds has been recognized since Biblical time that plants growing together compete for light, space, nutrients and water. Differences in weed suppression among crop or cultivar have long been established (Worthman, 1993; Blackshaw, 1994) [18, 3] and the need to study the competitiveness of modern mustard cultivars against weeds has been fully recognized. Although differences in competitiveness among mustard cultivars exist, but such variability in traits among species has not yet been explored in mustard. According to Blackshaw (1994) [3], cultivar for sustainable system should be both high yielding and competitive against weeds. Production potentiality of mustard can be fully exploited with suitable agronomic practices and genotypes. Among the different agronomic practices, the best method and time of weed control plays an important role to fully exploit the genetic potentiality of a variety as it provides optimum growth conditions.

Material and method
The experiment was conducted during winter (*rabi*) season of 2011-12 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (India), situated under North East Plain Zone of the country. The geographical situation of the farm lies in the North-Gangetic Alluvial plain at 25^{0}18$^{'}$ North latitudes, 83^{0}03$^{'}$ East longitude and at an altitude of 128.93 meters above the mean sea level. The soil of experimental field was in texture, low (4.0 g kg^{-1}) in Organic Carbon (Walkley and Black,

1934) [17] and Alkaline potassium permanganate digestible available nitrogen (182.52 kg ha^{-1}), Medium in 0.5 M $NaHCO_3$ extractable phosphorus (19.40 kg ha^{-1}) and ammonium acetate extractable potassium (235.3 kg ha^{-1}) with 7.28 pH, 0.27 dS m^{-1}EC. Soil Texture of experimental field was estimated through Textural triangle described by Black *et al*. (1965) [2] through measurement of relative proportion of sand, silt and clay through hydrometer method described by Bouyoucos (1962) [4]. Considering the nature of factors under study and the convenience of agricultural operation and efficiency, the experiment was laid out in Factorial Randomized Block Design comprised of 14 treatment combinations along with three replications. The treatment comprising of seven varieties *i.e.* Kranti, Rohini, Basanti, Maya, NRCHB-101, Ashirwad and Varuna and two weed treatments including weed free and weedy check. Mustard crop was fertilized with recommended dose of 80 kg N, 40 kg P_2O_5 and 40 kg K_2O ha^{-1}. Half the amount of nitrogen and total P_2O_5 and K_2O were applied as basal at the time of sowing and rest of nitrogen was top dressed at the time of first irrigation. The fertilizers were applied through urea (46% N), diammonium phosphate (18% N and 46% P_2O_5) and muriate of potash (60% K_2O). The crop was sown at a row distance of 30 cm at the rate of 5 kg ha^{-1}. The sowing was done on 31 October 2011 in the fertilized row, opened with the help of *kudal* and covered the soil. Thinning of crops was done after 15 days of sowing in order to keep only one robust and healthy plant at a distance of 10 cm to maintain proper plant population. The crop was grown under irrigated condition and three irrigations were applied to one month interval to maintain optimum soil moisture for crop growth. Weed and crop samples for studying various crop and weed characters were collected from each individual plot. Weed samples were collected by placing a quadrat (0.25 x 0.25) randomly at four places in each plot. For recording biometric observation at regular interval, two sampling area i.e. one for destructive and other for non- destructive were marked. The observations on crop like plant height, number of functional leaves, SPAD value and branches were taken from non-destructive sampling area *i.e.* net plot area while the observation like leaf area and dry matter accumulation per plant were taken from destructive area i.e. area apart from net plot area. Oil content in seeds was estimated by Soxhlet's extraction method. For determining the significance between the treatment means and to draw valid conclusions, statistical analysis was made. Data obtained from various observations were analyzed as per the standard analysis of variance (ANOVA) procedure for factorial randomized block design. The significance of the treatment effect was judged with the help of 'F' test (Variance ratio). Standard error of mean was computed in all cases. The difference of the treatments mean was tested using Critical Difference (CD) at 5% level of probability where 'F' test reported significant differences among mean.

Results

A) Effect on weed dynamics

During the period of investigation weeds infested in mustard crop consisted of 9 species including monocot and dicot weeds. In dicot weed *Anagallis arvensis* L., *Chenopodium album* L., *Vicia sativa* L., *Parthenium hysterophorus* L., *Rumex dentatus* L., *Solanum nigrum* L., *Melilotus indica* (L.) were present. Among the dicot weeds, *Chinopodium album* was the pre dominant weed followed by *Solanum nigrum* and *Anagalis arvensis* during crop season. *Cynodon dactylon* and *Cyperus rotundus* were the monocot weeds present in the experimental field.

The density of monocot weeds, dicot weeds and total weeds in weedy check was maximum initially and decreased at subsequent stages. This may be attributed to initial slow growth of mustard crop which gave room for germination of weeds for longer period of the crop growth. The low density of monocot weeds, dicot weeds and total weeds at later stage was as a result of drying due to intense competition during subsequent crop growing periods. However, the density of monocot weeds remained more are less static and was lower than dicot weeds throughout the period of present study. The lowest density of total weeds and dry matter of weeds was recorded in Rohini which proved to its better competing ability with weeds as the rate of growth of Rohini was faster in comparison to other varieties. This was also due to more number of functional leaves in variety Rohini which might have intercepted most of the light and only the far red light could have penetrated the crop canopy causing inhibition of photosynthesis of weed species growing under the crop cover. These findings are in agreement with the findings of Kim and Moody (1980) [6].

The general increase in total weed dry matter was due to higher dry matter accumulation with advancement in age and additional dry mater produced by new weeds that appear later in growing season. Dry matter accumulation of the weeds as resulted by mustard varieties followed similar trend like weed density which may again to be attributed to greater competing ability of Rohini.

Weed free treatment recorded the lowest weed density as it almost completely removed both monocot and dicot weeds at all stages of crop growth. However, the density of monocot and dicot weeds was the maximum in weedy check. Dry matter of weeds was reduced significantly by weed free treatment as compared to weedy check treatment. Since dry matter accumulation is the ultimate result of growth of any plant, a reduction in dry matter of weeds may be attributed to reduced growth of weeds as influenced by weed treatments.

B) Effect on Crop Growth

Plant height increased along with advancement of the growth up to at harvest in all treatments. Among varieties, variation in plant height and number of leaves $plant^{-1}$ was significant, Rohini was recorded the highest plant height and number of leaves $plant^{-1}$ due to rapid initial growth habit, and the lowest plant height and number of leaves $plant^{-1}$ were recorded in Ashirwad due to its slow initial growth habit. Moolani *et al.* (1964) [8] established that height of plants constituted the most important factor in the competition. This may be attributed due to fact that Rohini had faster growth in upward direction and resulted in more height and faced minimum weed completion by providing shading effect on weeds and consequently had more number of leaves.

In general, plant height and number of leaves $plant^{-1}$ were the maximum with weed free which may be ascribed to minimum competition by weeds. Similar results were also reported by Ghosh and Bera (1986) [5].

Nitrogen is an integral part of chlorophyll molecule. In the present investigation higher chlorophyll content were recorded in Rohini. This may be attributed due to its higher uptake of nitrogen habit. Minimum chlorophyll content was noticed in Varuna. This may be attributed due to it genetic expression of these varieties. Among weed treatments, weed free gave significantly higher chlorophyll content than weedy check. This was attributed due to higher crop-weed competition in the weedy check condition in presence of

weeds. Similar result was witnessed by Rathore and Manohar (1989) [11].

Effect of varieties on number of primary and secondary branches per plant are due to their genetically potentiality. Number of primary and secondary branches per plant was the highest in Rohini which was at par with NRCHB-101 and lowest in Ashirwad. Marked variation in the number of primary and secondary branches per plant was also observed due to weed treatments. Number of primary and secondary branches per plant was recorded significantly higher under weed free treatment in comparison to weedy check. This may be due to lower population in the weed free plots which provide less completion with weed for the supply of carbohydrate and nutrients to the growing branches. Branching is closely related to nutritional status of mother shoot as all the branches receive carbohydrate and nutrients from the main shoots during early growth period. Similar results were also reported by Yadav *et al.* (1994) [19], Reddy and Avilkumar, (1997) [12], Singh *et al.* (2001) [14], and Rana and Pachauri (2001) [10].

C) Effect on Yield Components

Different varieties showed significant variation in seed and stover yields. Rohini recorded the highest seed and stover yields followed by NRCHB-101 and Basanti which may be attributed to differences in their potentiality to accumulate plant dry matter. Minimum yield was recorded in Ashirwad. Yield ultimately depends on the yield attributing characters *viz.* number of plants per unit area, number of siliquae plant^{-1}, number of seeds plant^{-1} and 1000-seeds weight. Since number of plants per unit area was constant, number of seeds plant^{-1} and 1000-seeds weight were higher in the variety as compared to other varieties of mustard which resulted higher seed yield in Rohini. These findings are in conformity with Sharma and Mishra (1997) [13]. Weed free treatment had significantly higher seed yield in comparison to weedy check treatment. The favourable effect of weed free treatment is well understable because of better weed control which allowed the crop plants to utilize nutrients, moisture, light and space more efficiently, resulting into better growth and development. This finding in close conformity with results was reported by Madhavilatha *et al.* (1997) [7] and Singh *et al.* (1999) [15]. Stover yield was also in same pattern as growth and yield attributing traits, as for as weed treatments were concern. Significant increase in stover yield was due to enhance vegetative growth and yield attributing traits. This result corroborates the finding obtained by Tomar *et al.* (1991) [16]. Almost the same trend was witnessed in harvest index as it was in case of yield components, NRCHB 101 recorded the highest harvest index. Weed free condition recorded higher harvest index than weedy check condition. Lower stover yield in proportion to seed associated under weed free treatment increased the value of harvest index. Similar finding was reported by Sharma and Mishra (1997) [13].

Being varietal trait oil content varied among mustard varieties and maximum oil content was found in Varuna followed by Basanti and Maya and minimum in Ashirwad. Weed free treatment recorded maximum oil content and minimum oil content was found in weedy check. Similar results were obtained by Pradhan (1993) [9].

Table 1: Monocot, dicot, total weeds population (m^{-2}) and dry matter production (g m^{-2}) of weeds as influenced by competitive behavior of mustard varieties against weeds.

Treatment	Weed population m^{-2}			Weed dry matter production (g m^{-2})
	Monocot weeds	Dicot weeds	Total weeds	
Varieties				
Kranti	3.77 (48.0)**	6.44 (148.3)	7.32 (194.0)	14.91
Rohini	3.57 (43.6)	5.91 (135.3)	7.04 (179.0)	13.66
Basanti	3.66 (44.3)	6.31 (147.6)	7.13 (183.6)	14.71
Maya	3.66 (45.6)	6.35 (138.3)	7.22 (188.6)	14.86
NRCHB-101	3.65 (43.6)	6.25 (137.0)	7.11 (182.6)	13.67
Ashirwad	3.99 (51.0)	6.60 (154.3)	7.46 (195.3)	15.81
Varuna	3.66 (46.3)	6.31 (146.0)	7.20 (187.6)	14.77
SEm±	0.09	0.13	0.08	0.43
CD (P=0.05)	0.25	0.38	0.24	1.26
Weed management				
Weedy Check	6.75 (44.61)	11.91 (141.2)	13.72 (187.2)	28.54
Weed Free	0.71(0.00)	0.71 (0.00)	0.71 (0.00)	0.71
SEm±	0.05	0.07	0.04	0.23
CD (P=0.05)	0.14	0.20	0.13	0.67

*NS- Non Significant ** Data is transformed to $\sqrt{x+0.5}$; Values in the parenthesis are original values

Table 2: Plant height, number of leaves, chlorophyll content, and number of primary and secondary branches as influenced by competitive behavior of mustard varieties against weeds.

Treatment	Plant Height at Harvest(cm)	No. of functional leaves per plant at 90 DAS	Chlorophyll content (SPAD value) at 90 DAS	No. of primary branches per plant at 90 DAS	No. of Secondary branches per plant at 90 DAS
Variety					
Kranti	202.6	35.9	41.9	5.3	10.9
Rohini	230.2	52.1	45.3	8.6	15.3
Basanti	205.8	38.9	43.4	6.3	13.0
Maya	203.2	36.1	42.4	5.4	11.4
NRCHB-101	217.2	50.8	44.7	8.2	13.7
Ashirwad	192.2	29.8	40.7	4.8	9.4
Varuna	205.2	36.9	42.5	5.5	12.4

SEm±	1.0	1.7	0.8	0.2	0.5
CD (P=0.05)	2.9	5.0	2.3	0.6	1.6
Weed management					
Weedy Check	210.2	39.5	42.3	6.0	11.8
Weed Free	213.7	42.4	43.6	6.5	12.7
SEm±	0.5	0.9	0.4	0.1	0.3
CD (P=0.05)	1.5	2.7	1.2	0.3	0.8

Table 3: Seed yield, Stover yield, Harvest index and Oil content as influenced by competitive behavior of mustard varieties against weeds.

Treatment	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest Index	Oil Content (%)
Variety				
Kranti	1734	5297	24.7	39.8
Rohini	2102	5993	26.0	39.7
Basanti	2031	5533	26.9	41.7
Maya	1848	5432	25.4	41.3
NRCHB-101	2082	5557	27.3	39.9
Ashirwad	1719	5029	25.5	38.5
Varuna	1930	5472	26.1	42.1
SEm±	24.9	30.7	0.3	0.21
CD (P=0.05)	72.4	89.1	0.8	0.61
Weed management				
Weedy Check	1864	5439	25.5	39.6
Weed Free	1978	5565	26.2	41.3
SEm±	13.3	16.4	0.1	0.11
CD (P=0.05)	38.7	47.6	0.4	0.33

Conclusion

On the basis of results foresaid conclusion could be drawn that the maximum value of growth as well as yield of crop were produced with Rohini among rest of the mustard verities and it was found to be the most competitive in minimizing crop weed competition and maximizing yield against infestation of all naturally occurring weeds.

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