



Effect of herbal extracts on growth, physiological parameters, yield and yield attributes of Indian mustard

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Abstract

A field experiment was conducted during winter season of 2016-17 at ICAR-Directorate of Rapeseed and Mustard Research, Bharatpur, Rajasthan to evaluate the effect of herbal extracts on growth, physiological parameters, yield and yield attributes of Indian mustard (*Brassica juncea* L.). The experiment was laid out in randomized block design with four treatments and five replications, viz. herbal extracts, RDF + one irrigation, RDF + KNO₃ spray and Control. Results revealed that maximum plant height (231.2 cm), plant leaves (49.6), Leaf area index (5.9), chlorophyll content (50.8), primary (7.3) and secondary branches (20.6) had with T₂ treatment receiving RDF + one irrigation. The yield and yield attributes; length of silique (5.1 cm), number of seeds/silique (17.0), and test weight (5.2 g) were highest under the treatment of RDF+one irrigation as compared to other treatments. This study indicated that application of recommended dose of fertilizers with one irrigation at 65 days after sowing was found more beneficial in terms of getting higher yield and plant growth in climatic conditions of Rajasthan.

Key words: Chlorophyll content, herbal extract, irrigation, leaf area index, mustard, yield

Introduction

India is struggling to reduce import of edible oils by increasing acreage, and production under the oilseeds, while edible oils requirement is projected to rise to the tune of 20.4 million tones in 2020–2021. At the current trends, 39.2 million tons of vegetable oil will be required for the 1.68 billion populations in India by half of the 21st century (Jat *et al.*, 2019). To fulfill the demand of burgeoning population, oilseed brassica has to contribute 20.5 million tones of production (assuming a contribution at 25% in total oilseeds production) by the year 2050 which is a gigantic task for the scientists and policy makers. Indian mustard is a Rabi crop that required relatively cool temperature, a fair supply of soil moisture during its growing season and a dry period during harvest. Indian mustard is predominantly cultivated in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat it is also grown under some non-traditional area of south India including Karnataka, Tamil Nadu and Andhra Pradesh. It is cultivated both under irrigated (79.2%) and rainfed (20.8%) condition. Being more responsive to fertilizers, gives better return under irrigation condition. Use of organic manure not only helps to sustain crop yield but also plays a key role by exhibiting both direct as well as indirect influence on the nutrients availability in soil by improving the physical chemical and biological properties of soil (Singh and Biswas, 2000; Meena *et al.*, 2018).

Among the organic farming practices use of herbal extract or plant extract or botanicals is the emerging concept. Many types of extract from different plant are use for numerous purposes. The utilization of plant extract have been revealed to be eco-friendly and efficient against many plant pathogen. Unlike the chemical farm inputs, extract derived from plants are biodegradable, non-toxic, non-polluting and non-hazardous to humans, animals and birds. Herbal extracts from different plants like *Terminalia chebula*, *Termenila belerrica*, *Terminalia arjuna*, *Ocimum sanctum*, *Azdrichta indica*, *Curcuma longa* etc. have been used in various crops as plant growth regulator or plant growth inhibitor. Neem (*Azdrichta indica*) is considered as the magical tree and hundreds of its active compounds are used in plant protection, neem pest fumigant, neem fertilizer, neem manure, neem compost, neem urea coating agent and neem soil conditioner.

Being a rainfed crop, nutrient management is little or non-existent leading to poor productivity. Site-specific nutrient management, optimum crop geometry, balanced NPK nutrition, management of natural resources, integrated approach to plant-water, nutrient and pest management and extension of rapeseed-mustard cultivation to newer areas under different cropping systems will play a key role in further increasing and stabilizing the productivity and production of rapeseed-mustard to meet out the 39

million tones of vegetable oil requirement in the country by 2050 AD. The present study was undertaken to investigate the effect of herbal extract vis-a-vis chemical fertilizers and irrigation on growth attributes and yield of Indian mustard.

Materials and Methods

Experimental site and Climate characteristics

The experiment was conducted during 2016-17 at research farm, ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur located at 77°30' E longitude, 27°15' N latitude and at an altitude of 178.37 meter above mean sea level. The region falls under Agro climatic Zone III a (semi-arid Eastern plain) with sub-tropical and semi-arid climate. The climate of this zone is typically semi-arid, characterized with wide range of temperature between summer and winter. High temperature with high wind velocity during summers and low temperature during winters are the characteristic features of climatic condition. The mean monthly meteorological observations recorded at ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan, India during the crop growth period. The mean weekly maximum and minimum temperature during the crop growing seasons of mustard fluctuated between 18.3 to 40.9°C and 3.5 to 22.1°C. The mean daily evaporation from USWB class a pan evaporimeter ranged from 1.0 to 9.7 mm per day. The average relative humidity fluctuated between 20.4 to 57.8 percent at noon. The bright sunshine hours varied from 5.9 in January to 9.3 in April. Rainfall received during 2016-17 was 55.8 mm.

Soil characteristics

The soil samples were collected from surface soil (0-15cm) and analyzed for soil physic-chemical properties with the help of standard methods. The experimental site was silty clay loam in texture (19.2% sand, 51.3% silt and 29.4% clay), pH (1:2 soil water suspension) 8.3, bulk density 1.52 g cm³, field capacity (by weight) 12.5 % and permanent wilting point was observed at 2.35%. The nutrient concentration in soil was also measured 0.24%, 126.3 kg/ha, 17.23 kg/ha, 149.3 kg/ha organic C, available N, available P and available K, respectively.

Treatment details and preparation of field

The experiment consisted of four treatments, viz. herbal extracts, RDF+one irrigation, RDF+KNO₃ spray and Control. The herbal extract was prepared using ecotypic vegetations based on traditional knowledge. The variety RH 406 was used as test crop. Mustard was cultivated as per the recommended package and practices of agronomy. The crop was harvested at 80 per cent siliques turned down yellowish brown. The plants from each net plot

area (28 m × 4.5 m) were harvested carefully and seed yield from each plot was recorded.

Observation recorded

Different observations were recorded at 45 DAS, 60 DAS, 90 DAS and harvest stage. The observations like plant height, branches per plant were taken from both area apart from net plot (28 m × 4.5 m). Observations on growth, physiological parameters, yield and yield attributing characters were recorded. The chlorophyll content was measured with SPAD chlorophyll meter reading (SCMR) after 45, 60 and 90 DAS. The leaf area index was calculated on the basis of leaf area to ground area. It is used to find out the assimilatory surface area occupied by the plants.

$$LAI = \frac{A}{P}$$

Where,

A = Leaf area/hill and P = ground area/hill

At harvest, randomly tagged plants, length of five siliques/plant was measured and expressed as mean length of siliques (cm). The seeds of ten selected siliques from respective branches were threshed, counted and average number was reported. While reported the average number of seeds per siliques, the number of seeds per siliques of respective branches has been averaged. The thousand seeds were randomly taken from the finally cleaned produce of each plot for recording test weight. Then weight of 1000 seeds of each plot was recorded separately. The total biomass harvested from each plot was threshed and cleaned. The seeds so obtained were weighed and then converted in to q ha⁻¹. Harvest index was calculated by the formula:

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (q ha}^{-1}\text{)}}{\text{Biological yield (q ha}^{-1}\text{)}} \times 100$$

Seed samples from all treatments were collected and analyzed for oil content (%) in seeds with the help of nuclear Magnetic Resonance Spectroscopy (New Port Analyzer).

$$\text{Oil content (\%)} = \frac{\text{Weight of seed sample (g)}}{\text{Weight of oil (g)}} \times 100$$

The data obtained on various observations were tabulated and analyzed factorial randomized block design with three replications by using the techniques of the analysis of variance (ANOVA) as suggested by Panse and Sukhatme

(1967) and the treatment was tested by F test shown their significance where critical difference (CD) at 5% level of significance was determined for each character to compared the differences among treatment means.

Results and Discussion

Plant Height

Data pertaining to plant height of mustard varies significant due to effect of the different treatment at different stages viz. 45, 60, 90 DAS and at harvest stage (Table 1). Among the different treatment the RDF+ one irrigation resulted maximum plant height with 60.1, 161.5, 231.2, 230.0 cm at 45, 60, 90 DAS and at harvest. The plant height had significantly increased up to 90 DAS and marginally declined at harvest stage. Plant height

significantly varied due to application of different kind of fertilizers and herbal extract at different DAS 45, 60 and 90 DAS and at harvest stage. Among different treatments, plant height was found significantly high under the treatment of RDF+one irrigation. Similar results were also reported by Rafiel *et al.* (2011).

Number of leaf

A significant variation was observed in number of leaves/plant at different stages of plant growth as influenced by application of different treatments (Table 1). Number of leaf was found significantly high under T₂ which were 16.3, 36.8 followed by T₃ treatment at different stages of plant growth *i.e.* 45, 60 DAS respectively.

Table 1. Mean plant height (cm) and number of leaves under various treatments

Treatments	Plant height				Number of leaves		
	45 DAS	60 DAS	90 DAS	At harvest	45 DAS	60 DAS	90 DAS
Herbal extract (T ₁)	59.4	158.9	222.9	219.2	14.8	31.7	43.2
RDF+one irrigation (T ₂)	60.1	161.5	231.2	230.0	16.3	36.8	49.6
RDF+KNO ₃ Spray (T ₃)	59.9	160.2	224.4	221.5	15.5	33.8	48.8
Control (T ₄)	58.5	155.1	219.2	216.6	13.3	30.2	42.9
SEm±	2.36	2.984	3.057	5.84	0.39	1.48	1.88
CD (P=0.05)	6.97	9.08	9.27	16.98	1.02	4.37	NS

Chlorophyll content

The data related that chlorophyll (%) at different growth stages of plant as influenced by application of various treatments are shown in table 2. Among different treatments, chlorophyll (%) was found significantly high under the treatment of T₂ with 44.98, 48.32 and 50.81 at 45, 60 and 90 DAS respectively. Chlorophyll content of leaves was recorded by SPAD meter. T₃ treatment found less chlorophyll content in comparison to T₂ (Kumawat *et al.* 2014).

The data related to leaf area index (LAI) at different stage of plant growth stage as influenced by application of different treatments are shown in table 2 also. Among different treatment, Significantly higher LAI was observed under treatment receiving RDF + one irrigation at 45, 60 and 90 DAS followed by Treatment T₃ (RDF+KNO₃) which was found at par with T₁ (herbal). The highest leaf area index (LAI) at 90 DAS was observed in T₂ which was statistically at par with T₃. On the other hand, the T₄ (Control) showed least LAI. These results corroborate with the findings of Bharati *et al.* (2003), Panda *et al.* (2004).

Table: 2. Effect of various treatments on chlorophyll (%) and Leaf area index at different stages of plant growth.

Treatments	Chlorophyll content (DAS)			Leaf area index (DAS)		
	45 DAS	60 DAS	90 DAS	45 DAS	60 DAS	90 DAS
Herbal extract (T ₁)	43.29	45.24	45.29	3.19	4.89	3.48
RDF+ one irrigation (T ₂)	44.98	48.32	50.81	3.84	5.89	4.12
RDF+KNO ₃ Spray (T ₃)	44.58	46.77	47.34	3.47	5.12	3.87
Control (T ₄)	39.74	42.94	43.18	2.47	4.34	3.17
SEm±	0.373	0.903	1.125	0.014	0.20	0.20
CD (P=0.05)	1.317	3.187	3.970	0.046	0.067	.068

Number of branches

Among various treatments, number of branches were reported significantly highest with T₂ followed by T₃ (RDF+KNO₃ spray) however, it was statistically at par with T₁ at different stages of plant growth (45, 60, 90 DAS). Among different treatments, number of branches was reported significantly higher in treatment T₂ which is statistically at par with T₃. These results were in

conformity with of Hasanuzzaman *et al.* (2008).

Silique Length

Length of silique (cm) as influenced by different treatments was presented in table 3. Among various treatments, silique length (cm) was significantly highest with T₂ (5.1) followed by treatment T₃ (4.9) and T₁ (4.9). Minimum silique length (cm) was found in T₄ (4.8).

Table: 3. Effect of different treatments on post harvest observations

Treatments	Primary branches	Secondary branches	Silique length (cm)	Number of seeds (silique ⁻¹)	Girth (cm)	Number of silique/plant	Test weight (gm)
Herbal extract (T ₁)	6.9	18.8	4.9	16.4	5.9	489.4	4.69
RDF+ one irrigation (T ₂)	7.3	20.6	5.1	17.0	7.3	551.0	5.20
RDF+KNO ₃ Spray (T ₃)	7.1	19.7	4.9	16.6	6.0	492.7	5.02
Control (T ₄)	6.3	17.3	4.8	15.1	5.9	468.8	4.52
SEm±	0.32	1.56	0.13	0.23	0.32	53.63	0.21
CD (P=0.05)	NS	NS	0.39	0.69	1.24	156.87	0.65

Number of seeds per silique¹

Data pertaining to number of seeds/silique as influenced by various treatments is given in Table 3. Among different treatments, number of seed/silique was found significantly highest in T₂ (17.0) followed by T₃ (16.6). Least number of seeds (silique⁻¹) was observed in T₄ (15.1). Among different treatments, number of seed/ silique⁻¹ was significantly highest under the treatment of T₂ which statistically at par with T₃. These results were supported by Sonani *et al.* (1999), Kingra and Kaur (2012).

Girth

The data pertaining to stem girth at harvest stage of plant growth as influenced by various treatments is presented in Tables 3. Various treatment combination found significantly higher in T₂ (7.3 cm) which was found at par with T₃ (6.0) followed by T₁ (5.9). Least stem girth was found in T₄ (4.5).

Number of silique per plant

The data pertaining to number of silique/plant as influenced by various treatments is given in table 3. Application of T₂ treatment recorded highest number of silique/plant (551) which was found at par with T₃ (492.7) and followed by T₁ (489.4). Least number of silique/plant was found in T₄ (468.8). Among different treatment, number of silique/Plant⁻¹ was found significantly higher in treatment T₂ which at par with T₃ Bhalerao (2001).

Test Weight

The 1000 seed weight recorded from different treatments

is presented in table 3. The data showed the variation in thousand seed weight among various treatments. A significantly highest test weight was found in T₂ (5.2) which was found at par with T₃ (5.0) and followed by T₁ (4.7). Least test weight (gm) was found in T₄ (4.5). The test weight of mustard seed increased significantly in T₂ compare to other various treatments. Similar findings were also reported by Mandal *et al.* (2000), Kingra and Kaur (2012), Paliwal and Singh (2014).

Seed yield (kg/ha)

The data pertaining to yield (kg/ha) as influenced by various treatment is given in table 4. Treatment of T₂ produced highest seed yield (2640.7 kg/ha) which was found at par with T₃ treatment (2501.7 kg/ha). The least

Table 4. Effect of different treatments on final yield (kg ha⁻¹) and harvest index (%)

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)	Oil content (%)
Herbal extract (T ₁)	2231.0	6752	24.8	42.1
RDF+one irrigation (T ₂)	2640.7	7104	27.1	42.5
RDF+KNO ₃ Spray (T ₃)	2501.7	7052	26.2	42.3
Control (T ₄)	1469.2	5142	22.2	41.97
CD (P=0.05)	521.6	NS	NS	0.69
SEm±	171.79	415.83	2.03	0.22

yield was recorded in T₄ (control) treatment (1469.2 kg/ha). The significantly highest seed yield of mustard under the treatment of T₂ was observed due to significant improvement in yield attributes. These results corroborate the findings of Panda (2000), Bhalerao (2001), Singh *et al.* (2002), Abraham (2010).

Stover yield (kg ha⁻¹)

The data pertaining to stover yield (kg/ha) as influenced by various treatment is given in table 4. Treatment T₂ recorded the highest stover yield (7104 kg) followed by T₃, T₁ and T₄ treatments. Among various treatments application of T₂ increased the stover yield by 29.4%, 30.1% and 31.8% over T₃, T₁ and T₄ respectively. Availability of more moisture to plants might have resulted in the production of more photosynthesis which might have helped in the translocation of more photosynthetage to seeds results in and increased in harvest index. The stover yield (kg ha-1) of mustard seed increased significantly in T₂ compare to other treatments of T₃, T₁ and T₄ produced minimum test weight.

Harvest index

The data pertaining to harvest index (%) as influenced by various treatment is given in Table 4. Among various treatments of significantly highest harvest index was calculated in T₂ (27.1) which is at par with T₃ (26.2) followed by T₁ (24.8). Least harvest index (%) was found in T₄ (22.2). The harvest index is the ratio between economic yield and biological yield and expressed in percentage which was varied due to different treatment. The harvest index of mustard was higher in T₂ and was found significantly superior over other treatments. T₂ being at par with T₃.

Oil Content (%)

The data pertaining to oil content as influenced by various treatments is given in Table 4. Highest oil content was observed with T₂ (42.5) which was statistically at par with T₃ (42.3) and followed by T₁ (42.1). Least oil content was found in T₄ (42.0).

Conclusion

Mustard is a one of the important oilseed crop in India. Its production is much influenced by the application of fertilizers and irrigation. Maximum plant height, plant leaves, primary and secondary branches, leaf area index, chlorophyll content, length of siliquae, number of seeds/siliquae, test weight, oil content, yield and harvest index was recorded highest with treatment receiving recommended dose of fertilizers N:P:K:S:Zn:B (80:40:40:5:1) along with one irrigation at 65 DAS. On the basis of our finding, it can be concluded that

recommended dose of fertilizers with single irrigation is beneficial for getting maximum seed yield of Indian mustard in the present ecology.

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